VOLUME 27 / NUMBER 10
MAY 23, 1989
ACC. NOS. N89-17564 TO N89-18406

STAR
AN ABSTRACT JOURNAL

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*Scientific and Technical Aerospace Reports*, Volume 27, is prepared by the NASA Scientific and Technical Information Facility operated for the National Aeronautics and Space Administration by RMS Associates.

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**US ISSN 0036-8741**

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Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facilities (air).

For related information see also *Astronautics.*

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For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

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Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

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## GEOSCIENCES

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Includes exobiology; planetary biology; and extraterrestrial life.

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Includes topology and number theory.

## PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

For related information see also *Engineering.*

**70 PHYSICS (GENERAL)** 1417

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

**71 ACOUSTICS** 1417
Includes sound generation, transmission, and attenuation.
For noise pollution see *45 Environment Pollution.*

**72 ATOMIC AND MOLECULAR PHYSICS** 1418
Includes atomic structure, electron properties, and molecular spectra.

**73 NUCLEAR AND HIGH-ENERGY PHYSICS** 1419
Includes elementary and nuclear particles; and reactor theory.
For space radiation see *93 Space Radiation.*

**74 OPTICS** 1420
Includes light phenomena and optical devices.
For lasers see *36 Lasers and Masers.*

**75 PLASMA PHYSICS** 1422
Includes magnetohydrodynamics and plasma fusion.
For ionospheric plasmas see *46 Geophysics.* For space plasmas see *90 Astrophysics.*

**76 SOLID-STATE PHYSICS** 1423
Includes superconductivity.
For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

**77 THERMODYNAMICS AND STATISTICAL PHYSICS** 1430
Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.
For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

**SOCIAL SCIENCES**

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

**80 SOCIAL SCIENCES (GENERAL)** N.A.
Includes educational matters.

**81 ADMINISTRATION AND MANAGEMENT** 1431
Includes management planning and research.

**82 DOCUMENTATION AND INFORMATION SCIENCE** 1431
Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.
For computer documentation see *61 Computer Programming and Software.*

**83 ECONOMICS AND COST ANALYSIS** N.A.
Includes cost effectiveness studies.

**84 LAW, POLITICAL SCIENCE AND SPACE POLICY** 1433
Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

**85 URBAN TECHNOLOGY AND TRANSPORTATION** 1433
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.
For related information see *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

**SPACE SCIENCES**

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.
For related information see also *Geosciences.*

**88 SPACE SCIENCES (GENERAL)** N.A.

**89 ASTRONOMY** 1433
Includes radio, gamma-ray, and infrared astronomy; and astrometry.

**90 ASTROPHYSICS** 1434
Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics.*

**91 LUNAR AND PLANETARY EXPLORATION** 1437
Includes planetology; and manned and unmanned flights.
For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**92 SOLAR PHYSICS** 1452
Includes solar activity, solar flares, solar radiation and sunspots.
For related information see *93 Space Radiation.*

**93 SPACE RADIATION** 1453
Includes cosmic radiation; and inner and outer earth's radiation belts.
For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

**GENERAL**

Includes aeronautical, astronautical, and space science related histories, biographies, and pertinent reports too broad for categorization; histories or broad overviews of NASA programs.

**99 GENERAL** 1453

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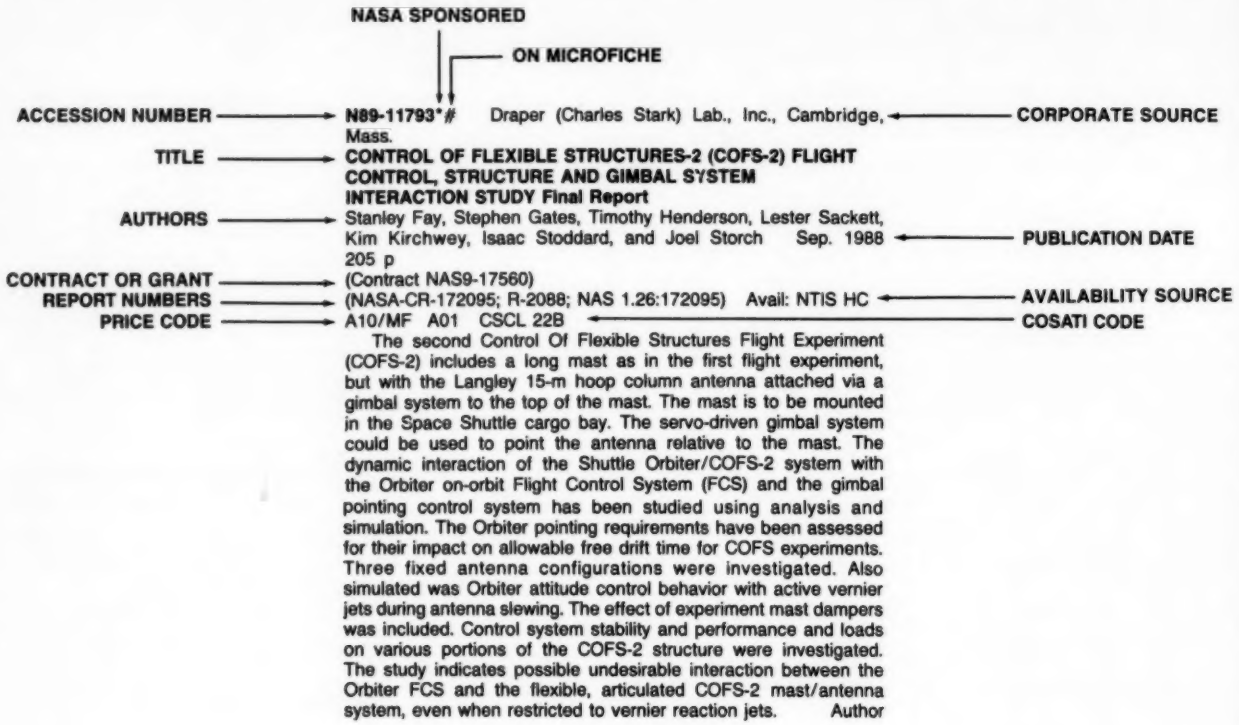
# TYPICAL CITATION AND ABSTRACT


NASA SPONSORED
ON MICROFICHE
ACCESSION NUMBER
N89-11793*#
Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
CORPORATE SOURCE
TITLE
CONTROL OF FLEXIBLE STRUCTURES-2 (COFS-2) FLIGHT CONTROL, STRUCTURE AND GIMBAL SYSTEM INTERACTION STUDY Final Report
AUTHORS
Stanley Fay, Stephen Gates, Timothy Henderson, Lester Sackett, Kim Kirchwey, Isaac Stoddard, and Joel Storch
Sep. 1988
PUBLICATION DATE
205 p
CONTRACT OR GRANT
(Contract NAS9-17560)
REPORT NUMBERS
(NASA-CR-172095; R-2088; NAS 1.26:172095)
Avail: NTIS HC
AVAILABILITY SOURCE
PRICE CODE
A10/MF A01 CSCL 22B
COSATI CODE
The second Control Of Flexible Structures Flight Experiment (COFS-2) includes a long mast as in the first flight experiment, but with the Langley 15-m hoop column antenna attached via a gimbal system to the top of the mast. The mast is to be mounted in the Space Shuttle cargo bay. The servo-driven gimbal system could be used to point the antenna relative to the mast. The dynamic interaction of the Shuttle Orbiter/COFS-2 system with the Orbiter on-orbit Flight Control System (FCS) and the gimbal pointing control system has been studied using analysis and simulation. The Orbiter pointing requirements have been assessed for their impact on allowable free drift time for COFS experiments. Three fixed antenna configurations were investigated. Also simulated was Orbiter attitude control behavior with active vernier jets during antenna slewing. The effect of experiment mast dampers was included. Control system stability and performance and loads on various portions of the COFS-2 structure were investigated. The study indicates possible undesirable interaction between the Orbiter FCS and the flexible, articulated COFS-2 mast/antenna system, even when restricted to vernier reaction jets. Author

VOLUME 27 NUMBER 10 / MAY 23, 1989

# Scientific and Technical Aerospace Reports

*A Semimonthly Publication of the National Aeronautics and Space Administration*

## 01 AERONAUTICS (GENERAL)

**N89-17564#** Army Missile Command, Redstone Arsenal, AL.
**REMOTELY PILOTED VEHICLE (RPV) TWO VERSUS THREE LEVEL MAINTENANCE SUPPORT CONCEPT STUDY Final Report**
Joseph H. Nordman, Wayne M. Leonard, Jr., and Adrian A. Abrams 15 Jan. 1988 67 p
(AD-A200665; AMSMI/LC-TA-88-01) Avail: NTIS HC A04/MF A01 CSCL 01C

Two maintenance support concepts for selected RPV subsystems lifetime supply and maintenance (S and M) costs are: (1) two levels of support, organizational and depot; and (2) three levels of support, organizational, intermediate (direct support and general support) and depot. Lifetime costs applicable to current peacetime conditions are estimated through the method of the Optimum Supply and Maintenance Model (OSAMM) which uses the supply model, called Selected Essential-Item Stockage for Availability Method (SESAME), as a subroutine. The unique features of OSAMM allows it to simultaneously minimize costs, develop maintenance task distributions, and quantities and placement of test equipment and stockage while achieving a pre-stated operational availability target. Results are presented over a range of operational availability values of interest in which supply quantities are variants. It is concluded that the three level support concept is less expensive than the two level concept for every selected subsystem studied except one - that one exception has a small cost impact. Another interesting conclusion reached for the three level concept is that the operational availability can be significantly improved with small stockage cost increases. GRA

## 02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

**N89-17565** Purdue Univ., West Lafayette, IN.
**AN EXPERIMENTAL INVESTIGATION OF THE FLOW FIELD AROUND A COUNTER-ROTATING PROPELLER SYSTEM USING A LASER DOPPLER VELOCIMETER Ph.D. Thesis**
Garry Lee Harrison 1987 202 p
Avail: Univ. Microfilms Order No. DA8814483

The flow field and performance characteristics of a two-bladed counter rotating propeller system were investigated. Investigations were conducted upstream, in between and downstream of the propellers for various relative angular propeller orientations. A two component laser Doppler velocimeter (LDV) system was used to investigate the flow field. Each LDV scan generated two velocity components and combining a horizontal and vertical scan allowed all three velocity parts to be determined. Complete sets of velocity parts at designated radial positions are presented showing the flow variation due to blade passage and the flow reversal across the vortex core. The importance of the phase angle is demonstrated in these plots. Thrust and power coefficients are determined from momentum and energy theory using average velocity values. These coefficients are compared to those determined analytically using a vortex lattice model. Dissert. Abstr.

**N89-17566** Old Dominion Univ., Norfolk, VA.
**FULL-POTENTIAL INTEGRAL SOLUTIONS FOR STEADY AND UNSTEADY TRANSONIC AIRFOILS WITH AND WITHOUT EMBEDDED EULER DOMAINS Ph.D. Thesis**
Hong Hu 1988 173 p
Avail: Univ. Microfilms Order No. DA8813660

The integral equation solution of the full potential equation is presented for steady and unsteady transonic airfoil flow problems. The method is also coupled with an embedded Euler domain solution to treat flows with strong shocks for steady flows. For steady transonic flows, three integral equation schemes are well developed. The three schemes are applied to different airfoils over a wide range of Mach numbers, and the results are in good agreement with the experimental data and other computational results. For unsteady transonic flows, the full-potential equation formulation in the moving frame of reference was used. The steady Integral Equation with Shock Capturing (IE-SC) scheme was extended to treat airfoils undergoing time-dependent motions, and the unsteady IE-SC scheme was thus developed. The resulting unsteady scheme was applied to a NACA 0012 airfoil undergoing a pitching oscillation around the quarter chord length. The numerical results are compared with the results of an implicit approximately-factored Euler scheme. Dissert. Abstr.

**N89-17567** Michigan Univ., Ann Arbor.
**UNSTEADY TRANSONIC CASCADE FLOWS Ph.D. Thesis**
Cheng-Chung Li 1988 135 p
Avail: Univ. Microfilms Order No. DA8812937

The performance of a jet engine can be improved by increasing the tip speed of the compressors. However, this improvement may lead to the problem of transonic blade flutter which will damage the structure of the compressors. A possible mechanism for this flutter involves shock wave oscillations in an unsteady transonic flow field between the blades. Progress in alleviating the problem can be made by studying the properties of the unsteady transonic flow over oscillating cascade flow. The purposes are threefold: first, to derive simple asymptotic solution for the aerodynamic moment acting on the blade, as a step toward predicting the occurrence of blade flutter; second, to derive a numerical method for computing solution to the Euler equations for unsteady transonic cascade flow; and third, to identify a possible source of transonic choke flutter, for which the shock wave motion between adjacent blades of a cascade appears likely to be a primary cause of the aeroelastic instability. Simple asymptotic solution of the full potential equations were derived for a cascade with force oscillations, for various combinations of the amplitude and the reduced frequency of the blade oscillation. Numerical solution of the Euler equations were also found by using a computer code based on a high-resolution TVD scheme, which utilizes a finite volume discretization with the MUSCL approach and flux vector splitting. Numerical results are presented for pressure and velocity distributions, and for the shock wave position, in a unstaggered cascade. Dissert. Abstr.

**N89-17568*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**NASA SC(2)-0714 AIRFOIL DATA CORRECTED FOR SIDEWALL BOUNDARY-LAYER EFFECTS IN THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL**
Renaldo V. Jenkins Washington, DC Mar. 1989 58 p
(NASA-TP-2890; L-16385; NAS 1.60:2890) Avail: NTIS HC A04/MF A01 CSCL 01A

This report presents the corrected aerodynamic data for A NASA SC(2)-0714 airfoil tested in the Langley 0.3-Meter Transonic Cryogenic Tunnel. This test was another in the series of tests involved in the joint NASA/U.S. industry Advanced Technology Airfoil Tests program. This 14 percent thick critical airfoil was tested at Mach numbers from 0.6 to 0.76 and angles of attack from -2.0 to 6.0 deg. The test Reynolds numbers were 4 million, 6 million, 10 million, 15 million, 30 million, 40 million, and 45 million. Corrections for the effects of the sidewall boundary layer have been made. The uncorrected data were previously published in NASA Technical Memorandum 4044. Author

**N89-17569** Texas Univ., Arlington.
**AN EXPERIMENTAL INVESTIGATION OF THE PERPENDICULAR VORTEX-AIRFOIL INTERACTION AT TRANSONIC SPEEDS Ph.D. Thesis**
Iraj Masbooghi Kalkhoran 1987 178 p
Avail: Univ. Microfilms Order No. DA8812828

Extensive studies were conducted in the UTA High Reynolds Number Transonic Wind Tunnel facility. The tests included a complete calibration of the wind tunnel over a wide range of transonic Mach numbers and at Reynolds numbers representing the normal operating condition of interest to aerospace vehicles. Experimental tests of the compressible trailing vortex system were performed by means of a thorough probing of the viscous core of the vortex system. Detailed flow field measurements and contour plots of the total pressure field in the neighborhood of the vortex core are presented. Thorough tests were conducted to investigate the pressure distribution on a C-141 and a NACA airfoil sections for a range of transonic flow conditions. The results obtained from these experiments indicate a substantial change in the pressure distribution of the downstream airfoil, a spanwise drift of the vortex core after interacting with the airfoil, and a high degree of unsteadiness in the vicinity of the vortex viscous core. Dissert. Abstr.

**N89-17570** Maryland Univ., College Park.
**VISCOUS OPTIMIZED HYPERSONIC WAVERIDERS DESIGNED FROM FLOWS OVER CONES AND MINIMUM DRAG BODIES Ph.D. Thesis**
Stephen Corda 1988 201 p
Avail: Univ. Microfilms Order No. DA8818379

A series of viscous optimized waveriders is designed from general axisymmetric flow fields, most notably, over minimum drag bodies. These configurations represent the next logical step in an ongoing program of research on the design of hypersonic waveriders. The design of waveriders from almost any axisymmetric flow fields is allowed, although the present results focus on the inviscid flows over cones, and 3/4 and 1/2 power law bodies. The power law bodies represent minimum wave drag bodies. A space marching, finite difference code is used to generate the axisymmetric flow field. Dissert. Abstr.

**N89-17571** Princeton Univ., NJ.
**SUPERSONIC TURBULENT BOUNDARY LAYER IN AN ADVERSE PRESURE GRADIENT Ph.D. Thesis**
Emerick Manley Fernando 1988 228 p
Avail: Univ. Microfilms Order No. DA8819583

The effects of an adverse pressure gradient on a flat plate supersonic turbulent boundary layer is described. The current pressure distribution was the same as on a previously studied curved wall model. The effects were studied of simple perturbations such as bulk compression so that combined effects of more than one simultaneous perturbation could be understood. In addition, by comparing the present experiment with the curved wall study, the effects of the combination of streamline curvature with bulk compression were identified. Results are provided that are interesting from the broad perspectives of conditional sampling and boundary layer structure. For example, it was shown that ensemble-averaged VITA events were less physically meaningful than ensemble-averaged quadrant events, as an ensemble-averaged VITA event was composed of individual quadrant events of different natures. It was also shown that many features of the observed large scale structures were consistent with vortex loop models for boundary layer structures. Dissert. Abstr.

**N89-17572** Pennsylvania State Univ., University Park.
**FIN GENERATED SHOCK-WAVE BOUNDARY-LAYER INTERACTIONS Ph.D. Thesis**
Frank Kerping Lu 1988 356 p
Avail: Univ. Microfilms Order No. DA8818024

An experimental investigation into fin generated shock wave boundary layer interactions was performed at nominal Mach numbers and at a nominal Reynolds number, with the primary aim of understanding the Mach number effects on interaction. A reduced shock strength parameter was identified which scaled the upstream influence, revealing clearly the conical nature of the interaction. The study also supported the conical free interaction concept. The incipient separation condition was also examined and a semi-empirical analysis was developed to support Korkegi's incipient separation criterion. Finally, laser lightsheet experiments revealed the possibility of a supersonic jet leaving the rear leg of the lambda-foot shock structure, and impinging onto the test surface. The shock structure and the impinging jet were also examined theoretically. Dissert. Abstr.

**N89-17573** California Univ., San Diego.
**AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF EXTERNAL FORCING ON THE WAKE OF A THIN AIRFOIL Ph.D. Thesis**
Katherine Williams Stuber 1988 256 p
Avail: Univ. Microfilms Order No. DA8817184

In an experiment which focuses on the effect of initial flow conditions on the wake of an airfoil, the strip heating technique is used to externally force the airfoil wake. The strip heaters are used to introduce waves into the top and bottom boundary layers of a thin symmetric airfoil which are subsequently amplified and introduced to the wake. The linear and nonlinear interactions of these waves in the wake are studied in detail. Two points of view are applied in the analysis of the data: (1) the effect of forcing on the fluid dynamical properties (such as velocity fluctuations, drag, and stability) of the system is examined, and (2) for the first time, a three frequency route to chaos in an open system is observed. Ideas from nonlinear dynamics are applied to the experimental data in an attempt to relate the basic physics of the system to the concepts of mode interaction and chaos. A connection is established between laminar chaotic flow and fully developed turbulent flow. Dissert. Abstr.

**N89-17574#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.).
**[ACTIVITIES REPORT IN FLOW MECHANICS] Annual Report, 1987 [FORSCHUNGSBEREICH STROEMUNGSMECHANIK - WISSENSCHAFTLICHER BEREICH - STAND 1987]**
Hans Joachim Holtz, ed. 1988 102 p In GERMAN Original contains color illustrations
(ISSN-0720-180X; ETN-89-93514) Avail: NTIS HC A06/MF A01

Calculation methods for design aerodynamics purposes were developed, configuration aerodynamics and acoustics were studied. Investigations in flow-physical fundamentals, numerical methods, and aerodynamic applications are outlined. Boundary layers and separated flow, cascade flow, transonic profile flow, jet simulation, space aerodynamics, flow field measurements, wind tunnel techniques, noise reduction, laser Doppler scanners, friction resistance, and stability of hot gas jets are discussed. Propfans,

compressor cascades, turbomachine flow, axial and radial compressors, turbine blades, and flow in combustion chambers were studied. ESA

**N89-17575#** Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Aerodynamik und Flugmechanik.
**DESIGN OF A CALIBRATION WING AS A MEASURING TOOL FOR THE INDIRECT DETERMINATION OF THE JET FLOW ANGLE IN A 5m X 7m SUBSONIC WIND TUNNEL**
Felix Hirt 16 Aug. 1988 56 p In GERMAN; ENGLISH summary Original contains color illustrations
(F+W-TF-1927; ETN-89-93538) Avail: NTIS HC A04/MF A01

A calibration wing for the indirect measurement of the local incoming flow direction in a subsonic wind tunnel test section was designed. Systematic error effects of the method were evaluated and check measurements with the calibration wing in the old tunnel test section were performed. The resolution of the flow angle measurement is found to be much better than that of a multiple-hole probe. A rapid survey of the jet angle distribution within the test section can be realized with the help of an automatically controlled sting support. ESA

**N89-17576#** Centre d'Etudes et de Recherches, Toulouse (France). Dept. d'Etudes et de Recherches en Aerothermodynamique.
**REDUCTION OF TURBULENT DRAG: BOUNDARY LAYER MANIPULATORS Final Report [REDUCTION DE TRAINEE DE FROTTEMENT TURBULENT: MANIPULATEURS DE COUCHE LIMITE]**
E. Coustols Mar. 1988 61 p In FRENCH
(Contract STPA-85-95-009-17)
(CERT-RSF-OA-70/2259-AYD; DERAT-54/5004/21; ETN-89-94097) Avail: NTIS HC A04/MF A01

The wind tunnel wall geometry and the model surface geometry were modified, carving riblets in the sense of the main flow, and changes induced in the flow were studied using hotwire anemometry and spectral analysis. Direct drag measurements on Airbus profiles indicate a drag reduction of 3.5 pct, and experiments using cylindrical bodies in transonic flow show results of drag reduction of up to 8 pct. ESA

**N89-17577*#** Johnson Aeronautics, Palo Alto, CA.
**WAKE MODEL FOR HELICOPTER ROTORS IN HIGH SPEED FLIGHT**
Wayne R. Johnson Nov. 1988 305 p
(Contract NAS2-12767)
(NASA-CR-177507; USAVSCOM-TR-88-A-008; NAS 1.26:177507) Avail: NTIS HC A14/MF A01 CSCL 01A

Two alternative approaches are developed to calculate blade-vortex interaction airloads on helicopter rotors: second order lifting-line theory, and a lifting surface theory correction. The common approach of using a larger vortex core radius to account for lifting-surface effects is quantified. The second order lifting-line theory also improves the modeling of yawed flow and swept tips. Calculated results are compared with wind tunnel measurements of lateral flapping, and with flight test measurements of blade section lift on SA349/2 and H-34 helicopter rotors. The tip vortex core radius required for good correlation with the flight test data is about 20 percent chord, which is within the range of measured viscous core sizes for helicopter rotors. Author

**N89-17578*#** McDonnell-Douglas Helicopter Co., Mesa, AZ.
**APPLICATION OF A COMPREHENSIVE ANALYTICAL MODEL OF ROTOR AERODYNAMICS AND DYNAMICS (CAMRAD) TO THE MCDONNELL DOUGLAS AH-64A HELICOPTER Final Report**
Cynthia B. Callahan and Duane E. Bassett Nov. 1988 62 p
(NASA Order A-63622-C)
(NASA-CR-177455; NAS 1.26:177455) Avail: NTIS HC A04/MF A01 CSCL 01A

A model of the AH-64A helicopter was generated in a Comprehensive Analytical Model of Rotorcraft Aerodynamics and Dynamics (CAMRAD) in an effort to validate its analytical capabilities for modeling a current advanced Army helicopter. The initial phase of the effort involved the generation of CAMRAD input files necessary for the complete aerodynamic, structural, and dynamic definition of the production AH-64A helicopter. The input files were checked by making comparisons of CAMRAD full helicopter trim and main rotor blade natural frequency predictions with those of full helicopter trim program, Blade Element Trim (BETRIM), and dynamic analysis code, Dynamic Analysis Research Tool (DART), respectively. The main thrust concerned the application of the AH-64A CAMRAD model thus developed and verified for main rotor blade structural loads predictions and comparison with DART analytical results. The investigation provided insight not only into the usefulness of CAMRAD for the AH-64A performance and dynamics prediction, but also into the limitations of the program for modeling advanced rotor and fuselage systems. The model development effort is discussed, the results of the CAMRAD correlation studies presented, and some general conclusions are offered on the applicability of CAMRAD for rotor aeroelastic loads prediction for current and future rotorcraft configurations. Author

**N89-17579*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**TIP AERODYNAMICS AND ACOUSTICS TEST: A REPORT AND DATA SURVEY**
Jeffrey L. Cross and Michael E. Watts Dec. 1988 463 p
(NASA-RP-1179; A-87128; NAS 1.61:1179) Avail: NTIS HC A20/MF A01 CSCL 01A

In a continuing effort to understand helicopter rotor tip aerodynamics and acoustics, a flight test was conducted by NASA Ames Research Center. The test was performed using the NASA White Cobra and a set of highly instrumented blades. All aspects of the flight test instrumentation and test procedures are explained. Additionally, complete data sets for selected test points are presented and analyzed. Because of the high volume of data acquired, only selected data points are presented. However, access to the entire data set is available to the researcher on request. Author

**N89-17580#** Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.
**A NUMERICAL SIMULATION OF FLOWS ABOUT TWO-DIMENSIONAL BODIES OF PARACHUTE-LIKE CONFIGURATION**
Toru Shimada Jun. 1988 15 p
(ISAS-629; ISSN-0285-6808) Avail: NTIS HC A03/MF A01

Transient aerodynamic characteristics of the flows around bodies of parachute-like configuration are numerically analyzed from the solution of the Navier-Stokes equations. The computational method is mainly based upon the combination of effective and efficient techniques recently developed in the field of computational fluid mechanics. The results show that the flow behavior around a mouth plays a key role in determining the maximum peak drag acting on the parachute-like body in the starting period from the rest and also a vent is effective in controlling the starting peak of the drag. Author

**N89-17581#** Bolt, Beranek, and Newman, Inc., Canoga Park, CA.
**NOISE AND SONIC BOOM IMPACT TECHNOLOGY. BOOMAP2 COMPUTER PROGRAM FOR SONIC BOOM RESEARCH. VOLUME 3: PROGRAM MAINTENANCE MANUAL Final Report, Jul. 1986 - Nov. 1987**
Philip J. Day, Thomas M. Reilly, and Harry Seidman Aug. 1988 412 p
(Contract F33615-86-C-0530)
(AD-A200992; BBN-6489; HSD-TR-88-001-Vol-3) Avail: NTIS HC A18/MF A01 CSCL 20A

Air Combat Maneuvering Instrumentation/Tactical Air Combat Training Systems (ACMI/TACTS) are used at several Military Operating Areas (MOA) in the U.S. and abroad as postflight pilot debriefing aids in training for air-to-air combat. Engineering flight data are acquired and recorded from several radar facilities

simultaneously during flights in appropriately instrumented MOAs. These data are used to generate the information required for subsequent graphical replays of the aircraft position, airspeed, g-value, altitude , climb/dive angle , etc. of the training sorties at post-flight debriefings. The BOOMAP2 and MOAOPS computer programs analyze noise from supersonic aircraft operations by extracting information from the ACMI/TACTS computer tapes. The MOAOPS program extracts information from a TACTS/ACMI mission standard data tape and compiles a computer library of information concerning the supersonic operations. The BOOMAP2 program, using the library produced by the MOAOPS program, calculates statistics on the supersonic operations and expected sonic boom levels on the ground based on the extracted information. Volume 3 provides computer programming personnel with the information to maintain the BOOMAP2 program software. The BOOMAP2 program uses a sophisticated acoustic ray theory model for predicting the sonic boom overpressures and noise levels on the ground. GRA

**N89-17582#** Naval Surface Weapons Center, Silver Spring, MD.
**NOTES ON A THEORETICAL PARACHUTE OPENING FORCE ANALYSIS APPLIED TO A GENERAL TRAJECTORY Final Report, 1987 - 1988**
William P. Ludtke 28 May 1988 72 p
(AD-A201050; NSWC-TR-88-6) Avail: NTIS HC A04/MF A01 CSCL 01C

The report presents a method for calculating the inflation reference time and opening shock forces of the solid-cloth family of parachutes when deployed at an arbitrary trajectory angle to the horizontal. The method is extended to other types of parachutes, but it is limited in that the inflation reference times are not calculated as part of the deployment process. Particular inflation times must be provided as input data to the furnished computer program. The variation of opening shock force versus inflation reference time may be surveyed by providing several values or using actual field test data. Examples are used to demonstrate the effects of canopy cloth rate of airflow, altitude, and trajectory deployment angle for constant velocity and constant dynamic pressure altitude profiles. GRA

**N89-17583#** VRA, Inc., Blacksburg, VA.
**PNS (PARABOLIZED NAVIER-STOKES) OF LARGE-ANGLE-OF-ATTACK VISCOUS HYPERSONIC FLOWS Final Report, 1 Jul. 1987 - 31 Jan. 1988**
Bilal A. Bhutta and Clark H. Lewis Mar. 1988 133 p
(Contract DAAL03-87-C-0015)
(AD-A201081; VRA-TR-88-01; ARO-25072.1-EG-SBI) Avail: NTIS HC A07/MF A01 CSCL 20D

A need has emerged for numerical schemes to predict hypersonic flows around three-dimensional configurations. The Army has shown considerable interest in applying 3-D Parabolized Navier-Stokes (PNS) schemes to study supersonic/hypersonic flowfields around projectiles and missiles. Although the existing noniterative PNS schemes offer an attractive combination of accuracy and affordability, such schemes suffer from several numerical instability and inaccuracy problems. This study develops a new 3-D PNS scheme with significantly enhanced stability and accuracy characteristics. This three-dimensional PNS scheme is inherently stable in the subsonic as well as the supersonic flow regions and, thus, does not require any sublayer approximation. It uses a generalized PNS formulation to treat perfect-gas and equilibrium-air gas models in a unified manner. A second-order smoothing approach is used to damp the solution oscillations, while a pseudo-unsteady approach is used to dramatically improve the solution efficiency without compromising the solution accuracy. A new fully-implicit and crossflow-coupled shock-fitting approach has been developed, along with a new predictor-corrector solution scheme to treat large crossflow separated regions. GRA

**N89-17825#** Rockwell International Science Center, Thousand Oaks, CA.
**HIGH RESOLUTION UPWIND FORMULATIONS FOR THE NAVIER-STOKES EQUATIONS**
Sukumar R. Chakravarthy *In* VKI, Computational Fluid Dynamics, Volume 2 1988 106 p (For primary document see N89-17824 10-34)
Avail: NTIS HC A17/MF A01

**N89-17826#** Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France).
**COMPRESSIBLE FLOW SOLVERS USING UNSTRUCTURED GRIDS**
J. A. Desideri and A. Dervieux *In* VKI, Computational Fluid Dynamics, Volume 2 1988 115 p (For primary document see N89-17824 10-34)
Avail: NTIS HC A17/MF A01

# 03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

**N89-17584*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**DESIGN OF AUTOMATION TOOLS FOR MANAGEMENT OF DESCENT TRAFFIC**
Heinz Erzberger and William Nedell Dec. 1988 35 p
(NASA-TM-101078; A-89058; NAS 1.15:101078) Avail: NTIS HC A03/MF A01 CSCL 01C

The design of an automated air traffic control system based on a hierarchy of advisory tools for controllers is described. Compatibility of the tools with the human controller, a key objective of the design, is achieved by a judicious selection of tasks to be automated and careful attention to the design of the controller system interface. The design comprises three interconnected subsystems referred to as the Traffic Management Advisor, the Descent Advisor, and the Final Approach Spacing Tool. Each of these subsystems provides a collection of tools for specific controller positions and tasks. This paper focuses primarily on the Descent Advisor which provides automation tools for managing descent traffic. The algorithms, automation modes, and graphical interfaces incorporated in the design are described. Information generated by the Descent Advisor tools is integrated into a plan view traffic display consisting of a high-resolution color monitor. Estimated arrival times of aircraft are presented graphically on a time line, which is also used interactively in combination with a mouse input device to select and schedule arrival times. Other graphical markers indicate the location of the fuel-optimum top-of-descent point and the predicted separation distances of aircraft at a designated time-control point. Computer generated advisories provide speed and descent clearances which the controller can issue to aircraft to help them arrive at the feeder gate at the scheduled times or with specified separation distances. Two types of horizontal guidance modes, selectable by the controller, provide markers for managing the horizontal flightpaths of aircraft under various conditions. The entire system consisting of descent advisor algorithm, a library of aircraft performance models, national airspace system data bases, and interactive display software has been implemented on a workstation made by Sun Microsystems, Inc. It is planned to use this configuration in operational evaluations at an en route center. Author

**N89-17585#** Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.
**DEVELOPMENT OF NEW REDUNDANT FLIGHT SAFETY SYSTEM USING INERTIAL SENSORS**
Shigeki Tsukamoto Oct. 1988 18 p
(ISAS-634; ISSN-0285-6808) Avail: NTIS HC A03/MF A01

A Flight Safety System requires high reliability in its operation because of the crucial duty to decide to destroy a flying vehicle or not, etc., in a state of emergency. A new Flight Safety System, one totally independent of the old one, which depends on radar

information, is based on the principle of inertial navigation in calculating a real-time trajectory and impact points on earth by online PCM-telemetry data. This backup system has been applied to practical missions such as Halley and Ginga, with good success. An efficient, redundant system was created by connecting an ordinary personal computer to the line for speedy calculation in order to construct a transfer matrix for a single pole representation of altitude. Author

# 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

**N89-17586** Bundesanstalt fuer Flugsicherung, Frankfurt am Main (Germany, F.R.).
**[ACTIVITIES REPORT IN AIR TRAFFIC CONTROL] Annual Report, 1987 [JAHRESBERICHT 1987]**
Jul. 1988 52 p In GERMAN
(ETN-89-93513) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514 Eggenstein-Leopoldshafen 2, Federal Republic of Germany

Measures taken to improve to safety and regularity of air traffic in West Germany are outlined. Navigation and radiotelephone techniques; information transmission techniques; radar techniques, information techniques; and maintenance of data processing systems are discussed. ESA

**N89-17587#** Sandia National Labs., Albuquerque, NM.
**ADVANCED FIGHTER TECHNOLOGY INTEGRATION/SANDIA INERTIAL TERRAIN-AIDED NAVIGATION (AFTI/SITAN) Final Report**
J. Rick Fellerhoff Nov. 1988 250 p
(Contract DE-AC04-76DP-00789)
(DE89-004000; SAND-88-1325) Avail: NTIS HC A07/MF A01

Sandia Inertial Terrain-Aided Navigation (SITAN) provides continuous position fixes to an Inertial Navigation System (INS) by real-time comparison of radar altimeter ground clearance measurements with stored digital terrain elevation data (DTED). This is accomplished by using an extended Kalman filter algorithm to estimate the errors in the reference trajectory provided by an INS. In this report, Sandia National Laboratories documents the results of a reimbursable effort funded by the Air Force Wright Aeronautical Laboratories (AFWAL) Avionics Laboratory to flight test SITAN as implemented onboard the Advanced Fighter Technology Integration (AFTI)F-16. DOE

**N89-17588#** Naval Postgraduate School, Monterey, CA.
**AN EVALUATION OF AUTOMATING CARRIER AIR TRAFFIC CONTROL CENTER (CATCC) STATUS BOARDS UTILIZING VOICE RECOGNITION INPUT M.S. Thesis**
Robert D. Jensen and John J. Spegele Jun. 1988 177 p
(AD-A200626) Avail: NTIS HC A09/MF A01 CSCL 25D

Conducting safe flight operations from aircraft carriers requires accurate and timely dissemination of aircraft status information from the Carrier Air Traffic Control Center (CATCC). Presently, the information is manually displayed on status boards throughout the ship by a network of sailors communicating via sound-powered microphones. A prototype, connected speech-based system, developed by the Naval Ocean Systems Command (NOSC), was evaluated. Specific evaluation criteria were the hardware, software and the man-machine interface. The use of connected speech as an input modality across varying noise and syntactic conditions was experimentally tested. The result of this research was the proposal of guidelines for designing connected speech syntaxes and specific recommendations for future prototype development efforts. GRA

# 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics.* For land transportation vehicles see *85 Urban Technology and Transportation.*

**N89-17589** Cranfield Inst. of Tech., Bedford (England).
**ANALYTICAL WING WEIGHT PREDICTION/ESTIMATION USING COMPUTER BASED DESIGN TECHNIQUES Ph.D. Thesis**
N. A. D. Murphy 1987 312 p
Avail: Univ. Microfilms Order BRDX82210

Every pilot knows that the size and position of masses in an aircraft has a fundamental effect on its performance. It comes as a surprise to learn that the methods used for predicting aircraft weights today were developed in the forties and there have only been half hearted attempts at making use of the digital computer. The usual methods are empirical and rely on experience gained from past projects. Things have changed and these methods are potentially inaccurate when applied by the inexperienced engineer to new aircraft based on radical concepts. Sixty percent of an airplane's program cost is determined at the initial stages of design and the structure of an aircraft accounts for up to 55 pct of the cost of a 200 aircraft program. Compare this with the 3 pct share that the initial design stage itself costs. Clearly the problem is that a small error can be very costly or even catastrophic.
Dissert. Abstr.

**N89-17590** Cranfield Inst. of Tech., Bedford (England).
**DESIGN SYNTHESIS FOR CANARD-DELTA COMBAT AIRCRAFT, VOLUMES 1 AND 2 Ph.D. Thesis**
V. C. Serghides 1987 554 p
Avail: Univ. Microfilms Order No. BRDX82026

The development of a computerized Design Synthesis is presented for canard-delta combat aircraft. The background to the work and the objectives and limitations are examined. The design of a baseline canard-delta combat aircraft is then described together with all the assumptions and decisions which led to its final configurations. The philosophy behind the progressive evolution of the aircraft geometry and packaging modules from the baseline configuration is explained in detail. The development of detailed modules for the estimation of the aircraft aerodynamics and performance is then presented. A full description of the investigations into the effects of canard-delta interference on the aircraft aerodynamics is also included. The mathematical content of the aircraft geometry, packaging, aerodynamics and performance modules is presented separately in the appendices in greater detail. The development and architecture of the Design Synthesis and graphics programs are finally presented and the program operation is described with the aid of flow charts. A comprehensive user manual and a design example are also provided. Dissert. Abstr.

**N89-17591#** Rockwell International Corp., Los Angeles, CA.
**SUPERPLASTIC FORMED ALUMINUM-LITHIUM AIRCRAFT STRUCTURE Interim Report, 30 Apr. 1987 - 30 Apr. 1988**
Gardner R. Martin, Claire Anton, Dean Klivans, M. A. Ramsey, P. S. McAuliffe, J. C. George, M. K. Guess, H. R. Pearson, C. C. Bampton, and R. A. Grimm (Edison Welding Inst., Columbus, OH.) et al Oct. 1988 133 p Prepared in cooperation with Washington State Univ., Pullman
(Contract F33615-87-C-3223)
(AD-A200245; NA-88-1347L; AFWAL-TR-88-3080) Avail: NTIS HC A07/MF A01 CSCL 01C

This program selects, designs, fabricates, and evaluates SPF Al-Li airframe parts using advanced joining technology; it also screens and evaluates SPF Al-Li alloys for application to candidate parts. Factors used in part selection include supportability, technical risk, and required development. A design trade study modifies and improves the advanced SPF Al-Li candidate parts by implementing efficient design concepts and advanced joining

methods. Design and joining methods are evaluated using material from the same lots used for material evaluation. Demonstration parts and the required tooling are fabricated using criteria generated from producibility evaluations. Finally, the demonstration parts are subjected to verification testing as prescribed in the test plan.
GRA

**N89-17592*#** Illinois Univ., Urbana. Dept. of Aeronautical and Astronautical Engineering.
**ADVANCED ENGINEERING DESIGN PROGRAM AT THE UNIVERSITY OF ILLINOIS FOR THE 1987-1988 ACADEMIC YEAR Final Report**
Kenneth R. Sivier and Michael F. Lembeck 15 Jun. 1988 33 p (Grant NGT-21-002-080)
(NASA-CR-184744; NAS 1.26:184744) Avail: NTIS HC A03/MF A01 CSCL 01C

The participation of the University of Illinois at Urbana-Champaign in the NASA/USRA Universities Advanced Engineering Design Program (Space) is reviewed for the 1987 to 88 academic year. The University's design project was the Manned Marsplane and Delivery System. In the spring of 1988 semester, 107 students were enrolled in the Aeronautical and Astronautical Engineering Departments' undergraduate Aerospace Vehicle Design course. These students were divided into an aircraft section (responsible for the Marsplane design), and a spacecraft section (responsible for the Delivery System Design). The design results are presented in Final Design Reports, copies of which are attached. In addition, five students presented a summary of the design results at the Program's Summer Conference. Author

**N89-17593*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**FLIGHT MEASURED DOWNWASH OF THE QSRA**
Joseph C. Eppel, Dennis W. Riddle, and Victor C. Stevens Dec. 1988 13 p
(NASA-TM-101050; A-88307; NAS 1.15:101050) Avail: NTIS HC A03/MF A01 CSCL 01C

Several reports have been written on the performance of the Quiet Short-Haul Research Aircraft, which shows the advantages of upper-surface blowing or the propulsive-lift wing as it applies to lift, maneuverability, and short takeoff and landing. This high lift generation at low speeds results in substantial downwash, especially in the low-aft fuselage tail position. The high T-tail of the Quiet Short-Haul Research Aircraft minimizes the undesirable downwash effects from the propulsive-lift wing. Queries from Department of Defense agencies and industry for quantitative values prompted a series of flight-measured downwash tests at the high T-tail and the low aft fuselage position. The results are presented in a summarized format, showing downwash, Delta epsilon/Delta a, for both locations. As would be expected, downwash increases for increased power and USB flap settings. The downwash is greater in the low aft-fuselage position as compared to the high T-tail area. Author

**N89-17594#** Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
**MPC-75 FEEDER CIVIL AIRCRAFT**
Ming Ke 1 Nov. 1988 6 p Transl. into ENGLISH from Guoji Hangkong (Peoples Repubic of China), no. 12(298), 1987 p 5
(AD-A200907; FTD-ID(RS)T-0857-88) Avail: NTIS HC A02/MF A01 CSCL 01C

The project model and partial prototype of the MPC-75 feeder civil aircraft, which was jointly developed and manufactured by the China Aviation Technology Import-Export Company and the MBB Company of the Federal Republic of Germany, was placed at the center of MBB Company exhibition platform in this year's Aviation Exhibit, and it drew a huge crowd. The MPC-75 is a class feeder civil aircraft with 75 to 90 seats, Based upon an extensive market investigation and analysis conducted by the two companies, this aircraft was selected to be the model to fill the open market for feeder civil aircraft with over 60 seats but under 100 seats. GRA

**N89-17595#** Defense Science Board, Washington, DC.
**REPORT OF THE DEFENSE SCIENCE BOARD TASK FORCE ON THE NATIONAL AEROSPACE PLANE (NASP) Final Report**
Sep. 1988 90 p
(AD-A201124) Avail: NTIS HC A05/MF A01 CSCL 01C

The NASP started in 1984 as a program to explore hypersonic air breathing propulsion. It transitioned during 1985 to a program with the dual goals of demonstrating single stage to orbit and hypersonic cruise with the same vehicle. DSB Task Force conclusions include: (1) The NASP program goals are valid. The NASP technologies will make significant contributions to our national military and space capabilities and our civilian economy as we enter the 21st century. (2) The NASP is truly an X-Vehicle. Expectations of short term operational utility should not be raised. (3) Technical uncertainties in all critical disciplines must be narrowed before detailed design is initiated. Uncertainties are too large to estimate with any degree of accuracy the cost, schedule or performance which can be achieved in Phase 3. (4) Readjust the program funding priorities to favor the Technology Maturation effort, while retaining sufficient effort in definition airframe and propulsion configuration to provide focus for the technology work. (5) An experimental program of this type should be event driven, not schedule driven. Demonstration of quantitative technical milestones in all critical disciplines should pace the program.
GRA

**N89-17691#** Saab-Scania, Linkoping (Sweden).
**AN ANALYSIS METHOD FOR BOLTED JOINTS IN PRIMARY COMPOSITE AIRCRAFT STRUCTURE**
Ingvar Eriksson *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 19 p Prepared in cooperation with Royal Inst. of Tech., Stockholm (Sweden). (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17693#** Dornier-Werke G.m.b.H., Friedrichshafen (Germany, F.R.). Technology Programs.
**TYPICAL JOINTS IN A WING STRUCTURE**
Dieter Rose, Manfred Rother, and Helmut Schelling (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart, Germany, F.R. ) *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 14 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-18380*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**V/STOL AIRCRAFT AND THE PROBLEM OF JET-INDUCED SUCKDOWN**
Cherianne Carlisle *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 9-20 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 01C

**N89-18387*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE NATIONAL AERO-SPACE PLANE**
Bruce Mendez *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 49-53 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 01C

# 06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

No abstracts in this category.

# 07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

**N89-17596** Virginia Polytechnic Inst. and State Univ., Blacksburg.

**AN EXPERIMENTAL AND NUMERICAL INVESTIGATION OF THE PERFORMANCE OF COMPESSOR CASCADES WITH STALLED FLOW Ph.D. Thesis**

Adam M. Yocum, II 1988 308 p

Avail: Univ. Microfilms Order No. DA8817428

How design variables affect the basic flow characteristics and performance of compressor cascades with stalled flow is determined. The performance of stalled cascades is required for analyzing with computer models stall and post stall behavior of axial flow compressors. The unsteadiness of the stalled flow and the stalled cascade performance as indicated by the blade normal force and total pressure loss were evaluated. The effects of stagger, angle of attack and Reynolds number were investigated experimentally using a 2-D cascade facility. Surface flow visualization, smoke flow visualization, velocity measurements and pressure measurements were used to evaluate the flow. The flow was modeled numerically by solving the Navier-Stokes equations for a cascade of flat plates. All of the results indicate that blade stagger is a key variable in determining the performance of a stalled cascade. The smoke visualization revealed that propagating stall occurred for the cascades with stagger at all angles of attack greater than or equal to the angle of full stall inception.

Dissert. Abstr.

**N89-17597** Bradford Univ. (England).

**TURBINE FLOWMETER SIGNAL ANALYSIS: SPECTRAL ANALYSIS OF TURBINE FLOWMETER PULSE TRAINS AND LOCAL LINE PRESSURES TO DETECT ROTOR FAULTS, PULSATING AND TWO-PHASE FLOWS, AND ASYMMETRIC VELOCITY PROFILES Ph.D. Thesis**

Adebayo Akinola Ajayi 1988 183 p

Avail: Univl Microfilms Order No. BRDX82836

It is shown that there is information other than the indicated flow rate contained in the pulse train of a turbine flowmeter. To do this, the notion of apparent pulsation is introduced. This refers to real pulsations in the rotor speed which occur when the fluid flow rate is not itself pulsating. Examples of where this effect may occur are, (1) asymmetric flow profiles, (2) support vanes, (3) swirl, (4) bearing torques, and (5) two phase flow. That this effect occurs is already known for some of these conditions, but apparent pulsation is defined to highlight the common basic mechanism by which this effect is generated. The process by which the rotor speed is converted to a pulse train is considered, and shown to be governed by Integral Pulse Frequency Modulation. This is shown to impose mathematical restrictions on the interpretation of the pulse train spectra. This is demonstrated by means of a computer model.

Dissert. Abstr.

**N89-17598** Minnesota Univ., Minneapolis.

**MEASUREMENT OF LOCAL MASS TRANSFER FROM A GAS TURBINE BLADE Ph.D. Thesis**

Ping-Hei Chen 1988 324 p

Avail: Univ. Microfilms Order No. DA8813040

The turbulent transport on a turbine blade of a planar cascade with and without the influence of the endwall was studied. The naphthalene sublimation technique used has several advantages compared with direct heat transfer measurements. For example, it is easy to manipulate and avoid errors resulting from surface conduction and radiation in heat transfer studies. In addition, it provides for more detailed information about the transfer rate than a heat transfer measurement. Although the heat transfer rate over a blade is not directly measured, the mass transfer results can be used to predict the heat transfer results by applying the heat/mass transfer analogy. Information about local transfer coefficients, over the entire blade, is obtained at 9216 loacations from four separate runs; two runs on the concave side and two on the convec side. The mass transfer rate on the convex surface in the region near the endwall is found to be extremely high, a result of small but intense corner vortices. The effect of changing the inlet boundary layer thickness on the mass transfer rate is also examined.

Dissert. Abstr.

**N89-17599*#** Adiabatics, Inc., Columbus, IN.

**ADIABATIC WANKEL TYPE ROTARY ENGINE**

R. Kamo, P. Badgley, and D. Doup Sep. 1988 208 p

(Contract NAS3-24880)

(NASA-CR-182233; NAS 1.26:182233; AI-120) Avail: NTIS HC A10/MF A01 CSCL 21E

This SBIR Phase program accomplished the objective of advancing the technology of the Wankel type rotary engine for aircraft applications through the use of adiabatic engine technology. Based on the results of this program, technology is in place to provide a rotor and side and intermediate housings with thermal barrier coatings. A detailed cycle analysis of the NASA 1007R Direct Injection Stratified Charge (DISC) rotary engine was performed which concluded that applying thermal barrier coatings to the rotor should be successful and that it was unlikely that the rotor housing could be successfully run with thermal barrier coatings as the thermal stresses were extensive.

Author

**N89-17600*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**THE EFFECT OF EXHAUST PLUME/AFTERBODY INTERACTION ON INSTALLED SCRAMJET PERFORMANCE**

Thomas Alan Edwards Nov. 1988 86 p

(NASA-TM-101033; A-88293; NAS 1.15:101033) Avail: NTIS HC A05/MF A01 CSCL 21E

Newly emerging aerospace technology points to the feasibility of sustained hypersonic flight. Designing a propulsion system capable of generating the necessary thrust is now the major obstacle. First-generation vehicles will be driven by air-breathing scramjet (supersonic combustion ramjet) engines. Because of engine size limitations, the exhaust gas leaving the nozzle will be highly underexpanded. Consequently, a significant amount of thrust and lift can be extracted by allowing the exhaust gases to expand along the underbody of the vehicle. Predicting how these forces influence overall vehicle thrust, lift, and moment is essential to a successful design. This work represents an important first step toward that objective. The UWIN code, an upwind, implicit Navier-Stokes computer program, has been applied to hypersonic exhaust plume/afterbody flow fields. The capability to solve entire vehicle geometries at hypersonic speeds, including an interacting exhaust plume, has been demonstrated for the first time. Comparison of the numerical results with available experimental data shows good agreement in all cases investigated. For moderately underexpanded jets, afterbody forces were found to vary linearly with the nozzle exit pressure, and increasing the exit pressure produced additional nose-down pitching moment. Coupling a species continuity equation to the UWIN code enabled calculations indicating that exhaust gases with low isentropic exponents (gamma) contribute larger afterbody forces than

high-gamma exhaust gases. Moderately underexpanded jets, which remain attached to unswept afterbodies, underwent streamwise separation on upswept afterbodies. Highly underexpanded jets produced altogether different flow patterns, however. The highly underexpanded jet creates a strong plume shock, and the interaction of this shock with the afterbody was found to produce complicated patterns of crossflow separation. Finally, the effect of thrust vectoring on vehicle balance has been shown to alter dramatically the vehicle pitching moment. Author

# 08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

**N89-18401*#** National Aeronautics and Space Administration, Washington, DC.
**CONTROLS AND GUIDANCE: AERONAUTICS**
John D. DiBattista *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 83-103 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 01C

# 09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

**N89-17601#** Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Aerodynamik und Flugmechanik.
**NEW DESIGN OF THE NOZZLE SECTION OF A LARGE SUBSONIC WIND TUNNEL**
Felix Hirt 24 May 1988 112 p In GERMAN; ENGLISH summary
(F+W-TF-1926; ETN-89-93539) Avail: NTIS HC A06/MF A01

The tunnel contraction of large subsonic wind tunnels was redesigned in order to optimize the nozzle contour with respect to length, wall pressure distribution, and boundary layer thickness development. The longitudinal contour was generated using a polynomial of high degree, such that all relevant boundary conditions can be fulfilled. The optimization shows that contours with a continuous wall curvature variation toward the exit of the contraction produce the smallest wall pressure peak. The analytically defined contour was realized with the help of longitudinal ribs and a rigid foam filling. Pressure measurements confirm the theoretical results quite well. ESA

**N89-17602#** Naval Postgraduate School, Monterey, CA.
**AN INEXPENSIVE REAL-TIME FLIGHT SIMULATOR FOR THE UNITED STATES MARINE CORPS' AIRBORNE REMOTELY OPERATED DEVICE M.S. Thesis**
Steven P. Martinson Jun. 1988 54 p
(AD-A200915) Avail: NTIS HC A04/MF A01 CSCL 05I

A flight simulator is developed for the Airborne Remotely Operated Device used by the United States Marine Corps. Real time interactive simulation is performed on a high speed graphics workstation. Accurately modeled dynamics are incorporated to reflect actual vehicle flight. The resulting system gives an operator the on board impression of flying through three dimensional terrain. This will provide realistic flight training at a fraction of the cost of a commercial simulator. GRA

**N89-17603#** Stanford Univ., CA. Dept. of Mechanical Engineering.
**INSTRUMENTATION FOR LASER-BASED FLOWFIELD IMAGING AND FLOW FACILITIES FOR DIAGNOSTICS RESEARCH Final Report, 1 Aug. 1986 - 31 Jul. 1988**
Ronald K. Hanson 6 Sep. 1988 9 p
(Grant AF-AFOSR-0272-86; AF Proj. 2917)
(AD-A200924; AFOSR-88-1165TR) Avail: NTIS HC A02/MF A01 CSCL 14B

This award has enabled acquisition of four state-of-the-art items of experimental apparatus to be used in research on diagnostics for combustion and plasma flows: a tunable excimer laser, a solid-state intensified camera system, a plasma diagnostics facility, and a laser-photolysis shock tube apparatus. All four systems are now operational and performing at or above initial expectations. GRA

**N89-18384*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE VERTICAL MOTION SIMULATOR**
Todd Hosein *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 33-37 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 14B

**N89-18388*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE WIND TUNNELS OF THE NATIONAL FULL-SCALE AERODYNAMICS COMPLEX**
John Moon *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 55-61 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 14B

# 12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

**N89-17604*#** Houston Univ., TX. Sasakawa International Center for Space Architecture.
**MANNED MARS EXPLORER PROJECT: GUIDELINES FOR A MANNED MISSION TO THE VICINITY OF MARS USING PHOBOS AS A STAGING OUTPOST; SCHEMATIC VEHICLE DESIGNS CONSIDERING CHEMICAL AND NUCLEAR ELECTRIC PROPULSION Final Report**
Sean Nolan, Deb Neubek, and C. J. Baxmann 16 May 1988 69 p
(Grant NGT-21-002-080)
(NASA-CR-184745; NAS 1.26:184745) Avail: NTIS HC A04/MF A01 CSCL 22A

The Manned Mars Explorer (MME) project responds to the fundamental problems of sending human beings to Mars in a mission scenario and schematic vehicle designs. The mission scenario targets an opposition class Venus inbound swingby for its trajectory with concentration on Phobos and/or Deimos as a staging base for initial and future Mars vicinity operations. Optional vehicles are presented as a comparison using nuclear electric power/propulsion technology. A Manned Planetary Vehicle and Crew Command Vehicle are used to accomplish the targeted mission. The Manned Planetary Vehicle utilizes the mature technology of chemical propulsion combined with an advanced aerobrake, tether and pressurized environment system. The Crew Command Vehicle is the workhorse of the mission performing many different functions including a manned Mars landing, and Phobos rendezvous. Author

**N89-18305*#** Grumman Aerospace Corp., Spring, TX.
**MARS SAMPLE RETURN MISSION: WHAT LEVEL OF COMPLEXITY**
Thomas M. Ciesla *In* Lunar and Planetary Inst., Workshop on

Mars Sample Return Science 1988 p 59-60 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 22A

**N89-18350*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**MARS ROVER SAMPLE RETURN: AN EXOBIOLOGY SCIENCE SCENARIO**
D. A. Rosenthal, M. H. Sims, Deborah E. Schwartz, S. S. Nedell, Christopher P. McKay, and Rocco L. Mancinelli *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 145-146 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 22A

**N89-18358*#** Colorado Univ., Boulder. Dept. of Astrophysical, Planetary, and Atmospheric Sciences.
**MARS ORBITAL TETHERED SAMPLE RETURN: THE FEASIBILITY AND USES OF OBTAINING ENTRAINED PARTICULATES FROM THE ATMOSPHERE Abstract Only**
S. A. Stern *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 162 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 22A

# 13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

**N89-18385*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**CIVIL ENGINEERING**
Katie Kenning *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 39-42 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 13B

# 14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

No abstracts in this category.

# 15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

**N89-17605#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.
**GUIDANCE AND CONTROL OF PRECISION GUIDED WEAPONS**
Nov. 1988 81 p In ENGLISH and FRENCH Symposium held in Geilo, Norway, 3-6 May 1988
(AGARD-CP-435; ISBN-92-835-0486-0) Copyright Avail: NTIS HC A05/MF A01

Topics relative to the guidance and control of guided missiles are discussed. Operational requirements and considerations; guidance sensors and components; guidance and control techniques and signal processing; system effectiveness and evaluation; and systems demonstration are among the topics considered. For individual titles, see N89-17606 through N89-17611.

**N89-17606#** Raytheon Co., Sudbury, MA. Equipment Div.
**CO2 LASER RADAR SYSTEMS FOR TARGET ACQUISITION AND GUIDANCE** **c36**
A. V. Jelalian, G. R. Osche, D. R. Bates, and A. J. Legere *In* AGARD, Guidance and Control of Precision Guided Weapons Nov. 1988 14 p (For primary document see N89-17605 10-15)
Copyright Avail: NTIS HC A05/MF A01

Laser radar systems combine the narrow beam width associated with optical systems with target measurement capabilities of microwave radar systems. The combined attributes of these distinctly different technologies lead to a single sensor capable of measuring range, velocity acceleration and angular location while still providing imaging capability. The best optical source for systems having this capability is the CO2 laser operating in the infrared band at 10.6 microns. Atmospheric propagation, coherent and incoherent detection receivers, and field test data collected over the past two decades are assessed. Author

**N89-17607#** Societe Francaise d'Equipments pour la Navigation Aerienne, Chatellerault (France).
**AQM: ACCELEROMETER FOR PRECISION-GUIDED WEAPONS [LAQM: ACCELEROMETRE POUR MUNITIONS DE PRECISION]**
A. Boura, O. Aujay, and J. L. Bost *In* AGARD, Guidance and Control of Precision Guided Weapons Nov. 1988 8 p In FRENCH (For primary document see N89-17605 10-15)
Copyright Avail: NTIS HC A05/MF A01

Pendular, monolithic accelerometer structures with surface areas of a few millimeters have been designed, fabricated and tested. The results support the possibility of applying this technology to homing weapons and projectile drift correction. Around these small monolithic structures it is possible to construct accelerometers which occupy a volume of between 1 and 4 cu cm. Certain prototypes have shown resistance to shocks up to 20,000 G, while others exhibit a static measuring range greater than 100 G. Recent experimental results and the extrapolations that can be deduced with regard to usable sensors for precision-guided weapons are discussed. Author

**N89-17608#** Litton Technische Werke, Freiburg (Germany, F.R.).
**PACKAGED FIBER OPTIC GYROS** **c35**
H.-J. Bueschelberger and W. Schroeder *In* AGARD, Guidance and Control of Precision Guided Weapons Nov. 1988 7 p (For primary document see N89-17605 10-15)
Copyright Avail: NTIS HC A05/MF A01

An overview of the Fiber Optic Gyroscope (FOG) - Attitude and Heading Reference Systems (AHRS) program and the outlook for the application of FOG for smart munitions are given. The main program is for the development of a FOG with a drift stability of 0.1 o/h, which is the class for strapdown AHRS. Flight tests with the LTR-81, Litton Technische Werke's standard AHRS, are scheduled for the end of 1988. Author

**N89-17609#** Prins Maurits Lab. TNO, Rijswijk (Netherlands).
**DEMONSTRATION OF FOG-M (FIBRE OPTIC GUIDED MISSILE) CAPABILITIES BY MEANS OF SIMULATION AND EFFECTS OF PROPRIOCEPTIVE FEEDBACK ON THE CONTROL**
B. J. Damen, R. N. H. W. vanGent, and H. Schuffel (Institute for Perception RVO-TNO, Soesterberg, Netherlands ) *In* AGARD, Guidance and Control of Precision Guided Weapons Nov. 1988 16 p (For primary document see N89-17605 10-15)
Copyright Avail: NTIS HC A05/MF A01

A simulated scenario with the Fiber Optic Guided Missile

(FOG-M) with the aid of a 6 degree of freedom simulation model for investigating maneuverability and footprint areas against stationary and moving ground targets is described. The performance against moving helicopters is discussed. A simulator built for research on the FOG-M system, including man-in-the-loop control, is described. Demonstration studies indicated some problem areas, such as the manual control characteristics. A study was started concerning which type of joystick system would enhance the performance of persons with minimal experience. It was shown that providing the operator with proprioceptive feedback on the maneuverability would enhance control performance. Author

**N89-17610#** Norwegian Defence Research Establishment, Kjeller.
**APPLICATIONS OF IMAGE ANALYSIS IN PRECISION GUIDED WEAPONS**
S. Grinaker *In* AGARD, Guidance and Control of Precision Guided Weapons Nov. 1988 17 p (For primary document see N89-17605 10-15)
Copyright Avail: NTIS HC A05/MF A01

An autonomous fire and forget weapon will have to automatically navigate from the launch site to the target area, detect and recognize the target, home on to it, and select an aim-point in the terminal phase. All of these tasks can be performed by using an imaging seeker-head. Image based target acquisition and tracking are well established ideas and implemented in weapons in operation or under development. A brief survey of the involved image processing techniques are provided, including a few examples of state-of-the-art algorithms. The basic ideas of image based navigation and aim-point selection are introduced and accompanied by examples, and the possibility of replacing the gyro stabilization by image processing is discussed. Finally, the problems concerning the implementation of image analysis for real time processing are addressed, and some principles for system design are provided. Author

**N89-17611#** Sverdrup Technology, Inc., Eglin AFB, FL. Operations Research Dept.
**STATISTICAL TECHNIQUES APPLIED TO ANALYSIS OF AIMPOINT DISTRIBUTIONS** **c65**
V. Darryl Thornton and Joseph M. Conrad *In* AGARD, Guidance and Control of Precision Guided Weapons Nov. 1988 8 p (For primary document see N89-17605 10-15)
Copyright Avail: NTIS HC A05/MF A01

The intent is to illustrate the application of several statistical techniques that seek to maximize the amount of information gained. A stepwise multiple regression technique is presented that assists in the identification of significant parameters. Having identified these parameters, a Chi-square goodness-of-fit technique is used to test the hypothesis that the form of the proposed aimpoint distribution is, as an example, bivariate normal. Finally, a second regression technique is presented that generates coefficients corresponding to those parameters that were found to be the most significant. Using these coefficients, sensor performance parameters may then be predicted in those areas where data is sparse. Author

# 16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

**N89-17612*#** Texas Univ., Austin.
**GATEWAY: AN EARTH ORBITING TRANSPORTATION NODE**
6 May 1988 124 p
(Grant NGT-21-002-080)
(NASA-CR-184751; NAS 1.26:184751; DR-2) Avail: NTIS HC A06/MF A01 CSCL 22B

University of Texas Mission Design (UTMD) has outlined the components that a space based transportation facility must include in order to support the first decade of Lunar base buildup. After studying anticipated traffic flow to and from the hub, and taking into account crew manhour considerations, propellant storage, orbital transfer vehicle maintenance requirements, and orbital mechanics, UTMD arrived at a design for the facility. The amount of activity directly related to supporting Lunar base traffic is too high to allow the transportation hub to be part of the NASA Space Station. Instead, a separate structure should be constructed and dedicated to handling all transportation-related duties. UTMD found that the structure (named Gateway) would need a permanent crew of four to perform maintenance tasks on the orbital transfer and orbital maneuvering vehicles and to transfer payload from launch vehicles to the orbital transfer vehicles. In addition, quarters for 4 more persons should be allocated for temporary accommodation of Lunar base crew passing through Gateway. UTMD was careful to recommend an expendable structure that can adapt to meet the growing needs of the American space program. Author

# 17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

No abstracts in this category.

# 18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

**N89-17613*#** Martin Marietta Aerospace, Denver, CO. Astronautics Group.
**SPACE STATION INTEGRATED PROPULSION AND FLUID SYSTEMS STUDY. SPACE STATION PROGRAM FLUID MANAGEMENT SYSTEMS DATABOOK**
B. Bicknell, S. Wilson, M. Dennis, and M. Lydon 26 Apr. 1988 231 p
(Contract NAS8-36438)
(NASA-CR-183583; NAS 1.26:183583; MCR-88-557) Avail: NTIS HC A11/MF A01 CSCL 22B

Commonality and integration of propulsion and fluid systems associated with the Space Station elements are being evaluated. The Space Station elements consist of the core station, which includes habitation and laboratory modules, nodes, airlocks, and trusswork; and associated vehicles, platforms, experiments, and payloads. The program is being performed as two discrete tasks. Task 1 investigated the components of the Space Station architecture to determine the feasibility and practicality of commonality and integration among the various propulsion elements. This task was completed. Task 2 is examining integration and commonality among fluid systems which were identified by the Phase B Space Station contractors as being part of the initial operating capability (IOC) and growth Space Station architectures. Requirements and descriptions for reference fluid systems were compiled from Space Station documentation and other sources. The fluid systems being examined are: an experiment gas supply system, an oxygen/hydrogen supply system, an integrated water

system, the integrated nitrogen system, and the integrated waste fluids system. Definitions and descriptions of alternate systems were developed, along with analyses and discussions of their benefits and detriments. This databook includes fluid systems descriptions, requirements, schematic diagrams, component lists, and discussions of the fluid systems. In addition, cost comparison are used in some cases to determine the optimum system for a specific task. Author

**N89-17614#** Committee on Science, Space and Technology (U.S. House).
**ORBITAL SPACE DEBRIS**
1988 111 p Hearing before the Subcommittee on Space Science Applications of the Committee on Science, Space and Technology, 100th Congress, 2d Session, No. 112, 13 Jul. 1988
(GPO-88-188) Avail: Subcommittee on Space Science and Applications of the Committee on Science, Space and Technology, House of Representative, Washington, D.C. 20515 HC free; SOD SN 552-070-048-69-3 HC $3.00

A Hearing before the Subcommittee of Space Science Applications of the Committee on Science, Space and Technology, of the House of Representatives (100th Congress, second session), on 13 July 1988, discussed the problem of orbital space debris. Some 7000 spent spacecraft rockets, spent upper stages, separation devices, fragments of exploded systems are abandoned in Earth orbit at a rough altitude of 800 miles, where they are being tracked by radar. They present a clear danger to future space flight. In addition, there is other orbital debris too small to be tracked by present day radar. Steps are being taken by NASA and DOD to try to reduce the amount of space debris being created, and to improve the ability of radar to track the smaller bits and pieces. F.M.R.

**N89-17615** California Univ., Los Angeles.
**SYMBOLIC GENERATION OF EQUATIONS OF MOTION FOR DYNAMICS/CONTROL SIMULATION OF LARGE FLEXIBLE MULTIBODY SPACE SYSTEMS Ph.D. Thesis**
Sheng Sam Lee 1988 169 p
Avail: Univ. Microfilms Order No. DA8814809

The formulation of equations of motion has become crucial in the successful design of very large and flexible space vehicles. The derivation is presented of explicit equations of motion for multibody flexible space systems via symbolic manipulation. This methodology generates very efficient computational algorithms in a reasonable amount of time and cost. Kane's dynamical equations are used to formulate the equation of motion. The multibody system is idealized as a collection of interconnected bodies arranged in a topological tree configuration with the option that the bodies can form closed loops. The flexible characteristics of the bodies are described by means of assumed admissible spatial functions. Bodies of the system are interconnected by hinges possessing zero to six degrees of relative motion freedom with unrestricted large rigid body motion. Dissert. Abstr.

**N89-17616#** Naval Postgraduate School, Monterey, CA.
**USE OF THE TRACKING AND DATA RELAY SATELLITE SYSTEM (TDRSS) WITH LOW EARTH ORBITING (LEO) SATELLITES: A DECISION GUIDE M.S. Thesis**
Allan R. Topp Jun. 1988 112 p
(AD-A200962) Avail: NTIS HC A06/MF A01 CSCL 22B

With increased military interest in relatively inexpensive, mission variable lightsats for proliferation and reconstitution purposes, an efficient means for information flow must be found. This information includes control of the mission satellite as well as retrieval of mission data. A possible selection to provide this channel is the Tracking and Data Relay Satellite System (TDRSS). This research was conducted to assemble the critical decision elements as a guide to prospective lightsat users of TDRSS. When TDRSS is complete, orbital coverage will be at least 85 percent, making this an attractive option. Greater link ranges and signal peculiarities are limiting factors in selecting this option. Issues covered TDRSS operational architecture, signal design and requirements, user spacecraft orbital considerations, link evaluation of all services for low earth orbits, and cost and documentation requirements. A recommended decision path is provided for early determination of TDRSSS suitability to mission needs. GRA

**N89-18389*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE SPACE STATION**
Abraham Munoz *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 63-67 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 22B

**N89-18402*#** National Aeronautics and Space Administration, Washington, DC.
**CONTROLS AND GUIDANCE: SPACE**
John D. DiBattista *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 105-125 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 22B

# 19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

**N89-18317*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A MARS ORBITAL LASER ALTIMETER FOR ROVER TRAFFICABILITY: INSTRUMENT CONCEPT AND SCIENCE POTENTIAL**
J. B. Garvin and M. T. Zuber *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 81-82 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 14B

**N89-18365*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SAMPLE SELECTION AND PRESERVATION TECHNIQUES FOR THE MARS SAMPLE RETURN MISSION**
Fun-Dow Tsay *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 173-174 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 14B

# 20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

**N89-17617*#** Tennessee Univ. Space Inst., Tullahoma. Center for Laser Applications.
**COMPUTATIONAL DESIGN OF AN EXPERIMENTAL LASER-POWERED THRUSTER Final Report, 9 Sep. 1986 - 8 Mar. 1988**
San-Mou Jeng, Ronald Litchford, and Dennis Keefer 24 Mar. 1988 145 p
(Contract NAS8-36220)
(NASA-CR-183587; NAS 1.26:183587) Avail: NTIS HC A07/MF A01 CSCL 21H

An extensive numerical experiment, using the developed computer code, was conducted to design an optimized laser-sustained hydrogen plasma thruster. The plasma was sustained using a 30 kW CO2 laser beam operated at 10.6 micrometers focused inside the thruster. The adopted physical model considers two-dimensional compressible Navier-Stokes equations coupled with the laser power absorption process,

geometric ray tracing for the laser beam, and the thermodynamically equilibrium (LTE) assumption for the plasma thermophysical and optical properties. A pressure based Navier-Stokes solver using body-fitted coordinate was used to calculate the laser-supported rocket flow which consists of both recirculating and transonic flow regions. The computer code was used to study the behavior of laser-sustained plasmas within a pipe over a wide range of forced convection and optical arrangements before it was applied to the thruster design, and these theoretical calculations agree well with existing experimental results. Several different throat size thrusters operated at 150 and 300 kPa chamber pressure were evaluated in the numerical experiment. It is found that the thruster performance (vacuum specific impulse) is highly dependent on the operating conditions, and that an adequately designed laser-supported thruster can have a specific impulse around 1500 sec. The heat loading on the wall of the calculated thrusters were also estimated, and it is comparable to heat loading on the conventional chemical rocket. It was also found that the specific impulse of the calculated thrusters can be reduced by 200 secs due to the finite chemical reaction rate. Author

**N89-17618*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**UNIQUE MISSION OPTIONS AVAILABLE WITH A MEGAWATT-CLASS NUCLEAR ELECTRIC PROPULSION SYSTEM**

E. P. Coomes, L. A. McCauley (Battelle Columbus Labs., OH.), J. L. Christian, M. A. Gomez, and W. A. Wong Oct. 1988 10 p Presented at the 24th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, Boston, MA, 11-14 Jul. 1988

(Contract DE-AC06-76RL-01830)

(NASA-TM-101220; NAS 1.15:101220; DE89-001738; PNL-SA-15519; CONF-880764-5) Avail: NTIS HC A02/MF A01 CSCL 21C

The advantages of using electric propulsion systems are well-known in the aerospace community with the most common being its high specific impulse, lower propellant requirements, and lower system mass. But these advantages may not be as important as the overall unique mission options electric propulsion makes possible, especially if the system is powered by a megawatt-class nuclear electric power source. Although the lack of suitable electric power systems has been a major drawback to electric propulsion, recent efforts have shown megawatt-class nuclear electric power systems are feasible and could be available by the turn of the century. Coupling this with the resurgence in interest in free-space electromagnetic transmission of energy and technology developments in this area provide a whole new aspect to the view of electric propulsion. The propulsion system now has a second mission function that may be of more value than the well understood benefits of electric propulsion; that is providing large quantities of prime power in support of a broad spectrum of mission tasks. DOE

**N89-17619*#** Universities Space Research Association, Huntsville, AL. Aerophysics Div.

**HOT WIRE ANEMOMETER MEASUREMENTS IN THE UNHEATED AIR FLOW TESTS OF THE SRB NOZZLE-TO-CASE JOINT Final Report**

N. Ramachandran Dec. 1988 44 p

(Contract NAS8-36474)

(NASA-CR-183528; NAS 1.26:183528) Avail: NTIS HC A03/MF A01 CSCL 21H

Hot-Wire Anemometer measurements made in the Solid Rocket Booster (SRB) nozzle-to-case joint are discussed. The study was undertaken to glean additional information on the circumferential flow induced in the SRB nozzle joint and the effect of this flow on the insulation bonding flaws. The tests were conducted on a full-scale, 2-D representation of a 65-in long segment of the SRB nozzle joint, with unheated air as the working fluid. Both the flight Mach number and Reynolds number were matched simultaneously and different pressure gradients imposed along the joint face were investigated. Hot-wire anemometers were used to obtain velocity data for different joint gaps and debond configurations. The procedure adopted for hot-wire calibration and use is outlined and the results from the tests summarized. Author

**N89-17620#** Research Inst. of National Defence, Stockholm (Sweden).

**ADHESION OF AN HTPB-BASED COMPOSITE PROPELLANT LINER TO MODERN ROCKET MOTOR CASE MATERIALS**

Roland Sanden and Niklas Wingborg Aug. 1988 31 p In SWEDISH; ENGLISH summary

(FOA-C-20729-2.1; ISSN-0347-3694; ETN-89-93736) Avail: NTIS HC A03/MF A01

A typical HTPB-based liner, which was used several years in case-bonded solid rocket engines and which has excellent adhesion to HTPB propellants and to steel, was studied with respect to adhesion to case materials, such as an aluminum alloy, an epoxy resin, and an epoxy-polyether-sulfane material. Excellent results are obtained for all the case materials. Recommended surface treatments are: for aluminum blasting and treatment with the isocyanate primer Desmodur R, for epoxy materials light grinding, and for other materials light grinding and treatment with Desmodur R. ESA

**N89-17621#** SeiTec, Cleveland, OH.

**DESIGN OF A kW, DC MAGNETICALLY CONTAINED ELECTROTHERMAL THRUSTER Final Technical Report, Jul. 1986 - Jul. 1987**

G. R. Seikel and C. V. Franks Jul. 1988 108 p

(Contract F04611-86-C-0057)

(AD-A200850; SEITEC-8716; AFAL-TR-87-066) Avail: NTIS HC A06/MF A01 CSCL 21C

This effort included: (1) the engineering design of a kW thruster, (2) the design and/or identification of all the equipment required to test the thruster, and (3) the fabrication of partial shear and containment coils of the thruster to demonstrate the suitability of their design. The resulting nominal 5 kW, completely magnetically contained thruster design has the potential for long operating life and an overall thrust efficiency between 60 and 80 percent in the specific impulse range of 2000 to 3000 seconds, i.e., 50 to 100 percent higher efficiency than any existing plasma thruster. This novel thruster concept produces thrust by the expansion of hot plasma in a pair of magnetic nozzles. Upstream containment of the plasma is achieved by a stable, stellarator-like, magnetic containment system. Plasma heating is accomplished by a DC discharge between the two anodes located inside the magnetic nozzle coils and a downstream hollow cathode located on a magnetic field line that passes near the center lines of the anodes. Almost all of the xenon propellant is injected into the discharge through the anodes. The resulting thruster should, based on the predicted performance, be very attractive for future orbital electrical propulsion. GRA

**N89-17622#** Systems Science and Software, La Jolla, CA.

**POLAR 2.0 VALIDATION AND PREFLIGHT SPEAR I (SPACE POWER EXPERIMENTS ABOARD ROCKETS) CALCULATIONS Interim Report**

G. A. Jongeward, M. J. Mandell, J. Lilley, and I. Katz Feb. 1988 36 p

(Contract F19668-86-C-0056)

(AD-A201094; SSS-R-88-9311; AFGL-TR-88-0056; SR-7) Avail: NTIS HC A03/MF A01 CSCL 12E

The authors present a description of the POLAR 2.0 code and data structure. POLAR 2.0 calculations of the self-consistent magnetosheath of a sphere in a magnetic field are presented and shown to be consistent with the Parker-Murphy limits. The POLAR code is shown to agree with the results of a 2-dimensional code for this symmetric case. Preflight SPEAR II calculation of the current distribution to the spheres, booms, and rocket body were performed for two of the voltage configurations. These results are presented here and compared with corresponding nonself-consistent calculations using the NASCAP/LEO code. GRA

# 23 CHEMISTRY AND MATERIALS (GENERAL)

No abstracts in this category.

# 24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.
For ceramic materials see *27 Nonmetallic Materials*.

**N89-17623** Lehigh Univ., Bethlehem, PA.
**STUDIES OF CREEP CAVITATION OF AISI TYPE 304 STAINLESS STEEL Ph.D. Thesis**
Tai-Sheng Liu 1988 369 p
Avail: Univ. Microfilms Order No. DA8817480

An experimental procedure for measuring creep cavities in AISI type 304 stainless steel is developed by using an automatic image analyzing system. A stereological analysis that approximates cavities by oblate area method while the crack growth resistance could be calculated by compliance method. Increases in the critical load and fracture energy due to fiber bridging are predicted by a power function of fracture area. The interlaminar fatigue crack growth behavior is studied through the constant cyclic strain energy release rate range test. A modification of Paris' power law is made to interpret fatigue crack growth under the influence of bridging. Fractography study shows that the interlaminar failure mechanism of composite beam might involve fiber break, matrix tearing and transverse microcracks as well as the delamination of the layers. Fatigue life prediction on composite materials is studied analytically using degradation and damage models, resultant strains and fatigue modulus. Static strength and fatigue life scattering of glass fiber reinforced epoxy composite materials was studied.
Dissert. Abstr.

**N89-17624** Pennsylvania State Univ., University Park.
**NUMERICAL TECHNIQUES FOR WAVE PROPAGATION AND SCATTERING PROBLEMS ASSOCIATED WITH ANISOTROPIC COMPOSITES Ph.D. Thesis**
Jiann-Hwa Jeng 1988 131 p
Avail: Univ. Microfilms Order No. DA8818008

The interaction of waves with anisotropic media is studied using numerical analysis. Two numerical techniques are developed and discussed. The first one is the hybrid finite element - T-matrix method for computing the far field scattering response of elastic waves scattered by a single anisotropic scatterer embedded in an elastic medium. The hybrid method retains the most efficient characteristics of finite element method and T-matrix method for computation of the scattering problems. The second technique is the finite element - eigenmode expansion method for computing the transmission and reflection characteristics of acoustic waves normally incident on a piezoelectric composite thin slab. Floquet modes are used to express the periodic field distributing in the infinite fluid medium. The possibility of the extension of both techniques to piezoelectric material problem has been suggested. It is concluded that these new approaches offer versatile analytical models for studying: (1) the far field scattering response of a single piezoelectric scatterer in elastic medium, and (2) the transmission and reflection characteristics of piezoelectric composites in fluid.
Dissert. Abstr.

**N89-17625*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**STRESS ANALYSIS METHOD FOR CLEARANCE-FIT JOINTS WITH BEARING-BYPASS LOADS**
R. A. Naik (PRC Kentron, Inc., Hampton, VA.) and J. H. Crews, Jr. Jan. 1989 32 p
(NASA-TM-100551; NAS 1.15:100551) Avail: NTIS HC A03/MF A01 CSCL 11D

Within a multi-fastener joint, fastener holes may be subjected to the combined effects of bearing loads and loads that bypass the hole to be reacted elsewhere in the joint. The analysis of a joint subjected to search combined bearing and bypass loads is complicated by the usual clearance between the hole and the fastener. A simple analysis method for such clearance-fit joints subjected to bearing-bypass loading has been developed in the present study. It uses an inverse formulation with a linear elastic finite-element analysis. Conditions along the bolt-hole contact arc are specified by displacement constraint equations. The present method is simple to apply and can be implemented with most general purpose finite-element programs since it does not use complicated iterative-incremental procedures. The method was used to study the effects of bearing-bypass loading on bolt-hole contact angles and local stresses. In this study, a rigid, frictionless bolt was used with a plate having the properties of a quasi-isotropic graphite/epoxy laminate. Results showed that the contact angle as well as the peak stresses around the hole and their locations were strongly influenced by the ratio of bearing and bypass loads. For single contact, tension and compression bearing-bypass loading had opposite effects on the contact angle. For some compressive bearing-bypass loads, the hole tended to close on the fastener leading to dual contact. It was shown that dual contact reduces the stress concentration at the fastener and would, therefore, increase joint strength in compression. The results illustrate the general importance of accounting for bolt-hole clearance and contact to accurately compute local bolt-hole stresses for combined bearings and bypass loading.
Author

**N89-17626#** Etablissement Technique Central de l'Armement, Arcueil (France). Service Chimie-Physique.
**STUDY OF THE EPOXIDE-AMMINE CONDENSATION REACTION BY NUCLEAR MAGNETIC RESONANCE. SYNTHESIS OF EPOXY-AMMINE MODELS [ETUDE DE LA REACTION DE CONDENSATION DE SYSTEME EPOXYDE-AMINE PAR RESONANCE MAGNETIQUE NUCLEAIRE SYNTHESE DE MODELES EPOXY-AMINE]**
J. Francillette, P.-J. Madec, and P.-A. Hoarau 17 Jun. 1987 18 p In FRENCH
(Contract DRET-REP-86)
(ETCA-87-R-055; ETN-89-94090) Avail: NTIS HC A03/MF A01

The aging of epoxy matrix composites was studied by characterizing the mono and polycondensed epoxy-amine condensates. Parameters are the initial reactive composant stoichiometry and the reaction temperature. The ability of the method to show the functional dependence of the concentration of organic species on the initial parameters is demonstrated. The presence of residual epoxy function is related to the volatility of the butylamine component. The low proportions of PGE oligomers and ethers is remarked.
ESA

**N89-17627#** Etablissement Technique Central de l'Armement, Arcueil (France). Service Chimie-Physique.
**AGING OF POLYMER MATERIALS AND COMPOSITES. EPOXY-AMMINE NETWORKS. RELATION OF STRUCTURE TO PROPERTIES [VIEILLISSEMENT DES MATERIAUX POLYMERIQUES ET COMPOSITES. RETICULES EPOXY-AMINES. RELATIONS STRUCTURES/PROPRIETES]**
A. Bergel, N. Wallez, and P.-A. Hoarau 30 Dec. 1987 50 p In FRENCH Sponsored by Direction de Recherches Etudes et Techniques, Paris, France
(ETCA-87-R-152; ETN-89-94091) Avail: NTIS HC A03/MF A01

The definition of the structure as a function of the cross linking rate is studied using an Arrhenius type approach. The method is based on the analysis of the absorption infrared spectra. The results show the independance of the activation energy with respect to the crosslinking rate or the hydrogen link contributions. This is found both for the polymerization process and the mechanical behavior of the studied materials.
ESA

**N89-17628#** Aerospatiale, Suresnes (France). Direction Centrale de la Qualite.
**ACOUSTIC EMISSION DAMAGE ASSESSMENT IN COMPOSITE MATERIALS: STUDY OF DIFFERED EMISSION [SUIVI PAR EMISSION ACOUSTIQUE DE L'ENDOMMAGEMENT DES MATERIAUX COMPOSITES, ETUDE DE L'EMISSION DIFFEREE]**
N. Rochat, B. Journet, P. Fleichmann (Institut National des Sciences Appliquees, Lyon, France ), and R. Esnault 6 Sep. 1988 67 p In FRENCH
(Contract STPA-86-96-009-00)
(RE-48-914/F; ETN-89-94094) Avail: NTIS HC A04/MF A01

A study on resin flow lead to the choice of a viscoelastoplastic model with five parameters to describe the behavior of composite materials. The similitude between acoustic emission behavior and macroscopic deformation allows adaptation of this model to acoustic analysis. The model is evaluated through changes in loading, specimen structure, and specimen geometry. A simple variable, the viscoelastic parameter, is identified as linking damage to acoustic emission. ESA

**N89-17629#** Institut National des Sciences Appliquees, Lyon (France).
**THEORETICAL AND EXPERIMENTAL ANALYSIS OF THE INFLUENCE OF MICROSTRUCTURE PARAMETERS UPON BRITTLE MATRIX COMPOSITES BEHAVIOR Ph.D. Thesis**
Patrick Peres 1988 330 p In FRENCH; ENGLISH summary
(ISAL-88-0052; ETN-89-94101) Avail: NTIS HC A15/MF A01

The influence of the microstructural parameters on SiC/LAS glass unidirectional composites during simple mechanical loading at room temperature was studied. An experimental ceramic composites characterization setup is described. Models describing the multiple matrix fracture in monofilament composites and the propagation of a matrix crack in fiber reinforced sheets are used in numerical simulations which include the interfacial sliding and the rupture statistics. ESA

**N89-17630#** Texas A&M Univ., College Station. Mechanics and Materials Center.
**RESEARCH ON DAMAGE MODELS FOR CONTINUOUS FIBER COMPOSITES Final Report, Apr. 1984 - May 1988**
D. H. Allen Jul. 1988 396 p
(Grant AF-AFOSR-0067-84; AF Proj. 2302)
(AD-A200771; MM-5023-88-8; AFOSR-88-1144TR) Avail: NTIS HC A17/MF A01 CSCL 11D

This report summarizes research completed during a four year period under AFOSR grant no. AFOSR-84-0067 and originally detailed under Texas A and M Research Foundation proposal no. RF-84-34 and dated October 1983. The objective of this research has been to develop an accurate damage model for predicting strength and stiffness of continuous fiber laminated composite media subjected to fatigue or monotonic loading and to verify this model with experimental results obtained from composite specimens of selected geometry and makeup. Further details of this research can be found in the three previous annual reports available either from AFOSR or the author. GRA

**N89-17631#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.
**PHENOMENOLOGICAL STUDIES IN MICROMECHANICS Final Report**
D. Post and R. Czarnek 30 Sep. 1988 54 p
(Contract N00014-86-K-0255)
(AD-A201092) Avail: NTIS HC A04/MF A01 CSCL 20K

State of the art experimental techniques have been applied to micromechanical measurements of advanced composite materials and structures. Moire interferometry has been used to determine the phenomenological nature of deformation of thick graphite epoxy laminates, and to measure representative mechanical properties. These properties include Young's modulus, Poisson's ratios, shear moduli and coefficients of thermal expansion. Test methods used for the measurement of shear moduli have been evaluated and a new test configuration proposed. The photomechanics experiments uncovered and quantified edge effects which were also studied in detail numerically. The practical nature of stresses, which are held in some circles to be singular, was investigated and the scale over which these effects act was determined. It would appear that a very fine scale and extremely high local stress gradients occur. GRA

**N89-17696#** Royal Armament Research and Development Establishment, Christchurch (England).
**TEST SPECIMENS FOR BEARING AND BY-PASS STRESS INTERACTION IN CARBON FIBRE REINFORCED PLASTIC LAMINATES**
M. B. Snell and G. P. Burkitt *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 21 p Original document contains color illustratons (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17699#** Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
**THE STATIC STRENGTH OF BOLTED JOINTS IN FIBRE REINFORCED PLASTICS**
F. L. Matthews *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 9 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17701#** Aeritalia S.p.A., Naples (Italy).
**JOINING OF CARBON FIBER COMPOSITE WITH FASTENERS**
Salvatore Pagliuso *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 5 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17702#** Avions Marcel Dassault, Saint-Cloud (France).
**BOLTED SCARF JOINTS IN CARBON COMPOSITE MATERIALS. COMPARISON BETWEEN ASSEMBLIES WITH AN INTERFERENCE FIT AND THOSE WITH PLAY [ENTURES BOULONNEES EN MATERIAUX COMPOSITE CARBONE COMPARAISON ENTRE MONTAGES A INTERFERENCE ET MONTAGE A JEU]**
Daniel Chaumette *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 10 p In FRENCH (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17705#** National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.
**BEHAVIOUR OF MECHANICALLY FASTENED JOINTS IN ADVANCED COMPOSITES**
C. Poon and R. Gould *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 14 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

# 25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

**N89-17632** ESDU International Ltd., London (England).
**THERMOPHYSICAL PROPERTIES OF ETHYLENE OXIDE**
Sep. 1988 17 p
(ESDU-88016; ISBN-0-85679-648-2; ISSN-0141-4062) Avail: ESDU

This Data Item 88016, an addition to the Sub-series on Physical Data, Chemical Engineering, tabulates the density, isobaric specific

heat capacity, specific enthalpy, viscosity and thermal conductivity of the liquid and vapor phases together with the vapor pressure, latent heat of vaporization and surface tension at 10 K intervals along the saturation line from the melting to the critical point of ethylene oxide. For the ideal gas, in addition, the enthalpy, isobaric specific heat capacity, viscosity and thermal conductivity are tabulated at 20 degree intervals in degrees Celsius and kelvins from the melting point to 1000 K at atmospheric pressure. The saturation data were obtained from an evaluation of the experimental data drawn from the literature and extrapolated values are indicated. Although the data are given in SI units, conversion factors to other common engineering units are included. ESDU

**N89-17633** ESDU International Ltd., London (England).
**THERMOPHYSICAL PROPERTIES OF PROPYLENE OXIDE**
Nov. 1988 15 p
(ESDU-88020; ISBN-0-85679-652-2; ISSN-0141-4062) Avail: ESDU

This Data Item 88020, an addition to the Sub-series on Physical Data, tabulates the density, isobaric specific heat capacity, specific enthalpy, viscosity and thermal conductivity of the liquid and vapor phases together with the vapor pressure, latent heat of vaporization and surface tension at 10 K intervals along the saturation line from the melting to the critical point of propylene oxide. For the ideal gas, in addition, the enthalpy, isobaric specific heat capacity, viscosity and thermal conductivity are tabulated at 20 degree intervals in degrees Celsius and kelvins from the melting point to 1000 K at atmospheric pressure. The saturation data were obtained from an evaluation of the experimental data drawn from the literature and extrapolated values are indicated. Although the data are given in SI units, conversion factors to other common engineering units are included. ESDU

**N89-17634#** Pacific Northwest Labs., Richland, WA.
**MULTIELEMENT DETECTOR FOR GAS CHROMATOGRAPHY**
D. S. Sklarew, J. C. Evans, and K. B. Olsen Nov. 1988 95 p
(Contract DE-AC06-76RL-01830)
(DE89-003771; PNL-6709) Avail: NTIS HC A06/MF A01

This report describes the results of a study to improve the capabilities of a gas chromatography-microwave-induced plasma (GC-MIP) detector system, determine the feasibility of empirical formula determination for simple mixtures containing elements of interest to fossil fuel analysis and, subsequently, explore applications for analysis of the complex mixtures associated with fossil fuels. The results of this study indicate that the GC-MIP system is useful as a specific-element detector that provides excellent elemental specificity for a number of elements of interest to the analysis of fossil fuels. It has reasonably good sensitivity for carbon, hydrogen, sulfur, and nickel, and better sensitivity for chlorine and fluorine. Sensitivity is poor for nitrogen and oxygen, however, probably because of undetected leaks or erosion of the plasma tube. The GC-MIP can also provide stoichiometric information about components of simple mixtures. If this powerful technique is to be available for complex mixtures, it will be necessary to greatly simplify the chromatograms by chemical fractionation. DOE

**N89-17635#** State Univ. of New York, Albany. Research Foundation.
**MECHANISTIC EXAMINATION OF ORGANOMETALLIC ELECTRON TRANSFER REACTIONS Progress Report**
1988 8 p
(Contract DE-FG02-87ER-13775)
(DE89-004128; DOE/ER-13775/1) Avail: NTIS HC A02/MF A01

Efforts have been directed toward construction of an infrared, stopped-flow spectrophotometer. This was essentially accomplished by July 1, 1988. We have also made progress on the reactions of metal carbonyl anions with metal carbonyl cations and metal carbonyl dimers. Reactions of Re(CO)5(-) with Mn(CO)6(-), phosphine, inorganic complexes and organometallic halides are discussed. DOE

**N89-17636#** Utah Univ., Salt Lake City.
**PULSED LASER PHOTOTHERMAL SPECTROSCOPY OF LIQUIDS AND SOLIDS Progress Report, 1 Dec. 1987 - 30 Nov. 1988**
Edward M. Eyring Nov. 1988 14 p
(Contract DE-FG02-84ER-13227)
(DE89-004866; DOE/ER-13227/5) Avail: NTIS HC A03/MF A01

Progress of research under this grant is reported since November 30, 1987 (the date of the last Progress Report). Several modifications of photoacoustic and photothermal spectroscopies have been applied to the study of the kinetics and quantum yields of photophysical processes in liquid sample systems. The thermal lens method has been used on a nanosecond time scale and has been found to have advantages over PVDF foil and optical beam deflection photoacoustic techniques. A combined thermal lens and photoacoustic beam deflection experiment has been applied to the study of several dyes that release almost all their excitation energy nonradiatively. Photoacoustic EXAFS experiments have confirmed quantitatively a theory of signal enhancement by volatile liquids. DOE

**N89-17637#** Kaiserslautern Univ. (Germany, F.R.). Fachbereich Maschinenwesen.
**COMBUSTION PROCESS AND SOOT EMISSION OF A PRECOMBUSTION CHAMBER DIESEL ENGINE, FOR DIFFERENT FUEL QUALITIES Ph.D. Thesis [BRENNVERLAUF UND RUSSEMISSION EINES VORKAMMER-DIESELMOTORS BEI UNTERSCHIEDLICHEN KRAFTSTOFFQUALITAETEN]**
Heiner Gerhard Wannemacher 1986 172 p In GERMAN
(ETN-89-93491) Avail: NTIS HC A08/MF A01

The combustion function process of Diesel engines was calculated on the basis of the measured cylinder pressure evolution, for engines with direct injection as well as with precombustion chamber. The calculation model was developed for engines with direct injection, but can also be applied to engines with precombustion chamber. The effects of load and number of revolutions on the combustion process of both engine types were calculated. The physical and chemical processes in soot formation are elucidated. The effect of the quality of Diesel fuels on emission of soot and solid and gaseous substances was determined. The test results can be interpreted using the calculated combustion function processes. ESA

**N89-17638#** Research Inst. of National Defence, Stockholm (Sweden).
**THERMOCHEMICAL CALCULATIONS OF COMBUSTION OF ALUMINUM, IRON AND COPPER UNDER IDEALIZED CONDITIONS IN A CONFINED VOLUME**
Sven-Erik Flygar and Goran W. Weibull Aug. 1988 34 p In SWEDISH; ENGLISH summary
(FOA-C-20730-2.3; ISSN-0347-3694; ETN-89-93737) Avail: NTIS HC A03/MF A01

The conditions inside an armored vehicle hit by an armorpiercing warhead were studied. The combustion was performed in a confined volume with air of different moisture content and temperature, and the metals initially at different temperatures. The calculations presuppose no leakage of heat and that chemical equilibrium exists. Computation results concerning pressure and temperature after combustion, and composition of combustion products are presented. Tests with two or three of these metals together are reported. Simplified formulas for pressure and temperature are shown. ESA

**N89-17639#** Oak Ridge National Lab., TN.
**SCINTILLATOR-FIBER FLOW-CELL RADIATION DETECTOR FOR LIQUID CHROMATOGRAPHY**
T. L. Rucker, H. H. Ross, and G. K. Schweitzer 1987 5 p Presented at the 33rd Annual Bioassay, Analytical and Environmental Radiochemistry Conference, Livermore CA., 6 Oct. 1987 Prepared in cooperation with Tennessee Univ., Knoxville.
(Contract DE-AC05-84OR-21400)
(DE89-001935; CONF-871061-4) Avail: NTIS HC A02/MF A01

We have designed and developed a new type of heterogeneous flow cell which is packed with aligned scintillator-fibers instead of the solid scintillator particles currently used in heterogeneous flow cells. The fiber-scintillator detector was designed to overcome the light scattering difficulties of the conventional heterogeneous type detector. Also, we expected the fiber cell would offer better back-pressure and compound retention characteristics due to reduced surface area and the alignment of the fibers. DOE

**N89-17640#** Texas Univ., Austin. Dept. of Chemistry.
**SURFACE ANALYSIS SYSTEM AND SURFACE RAMAN SPECTROSCOPY Final Technical Report, 1 Nov. 1986 - 31 Dec. 1987**
Alan Campion 5 Aug. 1988 5 p
(Grant AF-AFOSR-0070-87; AF Proj. 2917)
(AD-A200638; AFOSR-88-1038TR) Avail: NTIS HC A02/MF A01 CSCL 20E

A multipurpose surface analysis chamber equipped with X-ray photoelectron spectroscopy (XPS), ion scattering spectroscopy, secondary ion mass spectrometry and Auger electron spectroscopy has been constructed and installed. The Leybold LHS-12 system which was partially funded from this grant, comprises both high pressure and ultrahigh vacuum sample preparation and reaction chambers, thermal evaporation and radiofrequency sputtering sources and a rapid entry load lock. This system is fully operational, meeting all specifications, and is being used in a wide variety of surface science and other applications. These include the XPS study of the decomposition of alkyl halides in support of our surface Raman spectroscopy efforts, and XPS study of the X-ray induced degradation of thin polymer films and a study of the role of peroxide ions in the mechanism of high temperature superconductivity. A multipurpose surface analysis chamber equipped with X-ray photoelectron spectroscopy, ion scattering spectroscopy, secondary ion mass spectrometry and Auger electron spectroscopy has been constructed and installed. GRA

**N89-17641#** Aerodyne Research, Inc., Billerica, MA.
**THE 3-5 COMPOUNDS TRACE ELEMENT PROFILE ANALYSIS USING LASER ASSISTED SPECTROSCOPY Final Report, Aug. 1986 - Feb. 1987**
A. Freedman, K. McCurdy, and C. Stinespring Jul. 1988 33 p
(Contract F19628-86-C-0142)
(AD-A200955; ARI-RR-594; RADC-TR-88-162) Avail: NTIS HC A03/MF A01 CSCL 20L

A microprobe analysis technique which has the potential for quantitative measurements of surface and bulk concentration as well as depth profiles has been investigated. This technique is termed Profile Analysis using Laser Assisted Spectroscopy (PALAS) and uses one pulsed laser to desorb or vaporize a controlled volume of the sample and a second pulsed laser to induce fluorescence in the desorbed species. The intensity of the Laser Induced Fluorescence (LIF) provides a quantitative measure of the desorbed atom species concentration, while the energy density of the vaporizing laser controls the sampling depth. The requisite lateral resolution is provided by focusing the vaporizing laser. The purpose of the Phase 1 project was to demonstrate the feasibility of PALAS by making measurements of impurity and dopant concentrations in gallium arsenide, which is a 3 to 5 material of interest to the Air Force and other defense agencies. The system did not perform as well as anticipated. A number of deficiencies with the machine as constructed were noted. GRA

**N89-17642#** Southwest Research Inst., San Antonio, TX. Fuels and Lubricants Research Facility.
**KINETICS OF CARBOXYLIC ACID FORMATION IN THE COMBUSTION OF ALCOHOLS Interim Report, 4 Sep. 1986 - 1 Sep. 1987**
David W. Naegeli Dec. 1987 46 p
(Contracts DAAK70-87-C-0043; DAAK70-85-C-0007)
(AD-A200961; BLRF-254) Avail: NTIS HC A03/MF A01 CSCL 21B

Studies have shown that low-temperature operation of spark ignition engines on methanol fuel results in unusually high ring and cylinder bore wear. It has been found that the wear is caused by formic acid and peroxide formed in the low-temperature combustion of methanol. Bench studies have shown that combustion residues are formed when shallow pools of alcohols are burned. The residues were found to contain substantial concentrations of aldehydes, carboxylic acids, and peroxides. The objective of the present study was to measure rates and to determine the kinetics of formation of carboxylic acids and peroxides observed in residues formed by burning shallow pools of liquid alcohols. An examination of the literature suggested strongly that carboxylic acid formation in alcohol combustion was probably caused by the reaction of hydrogen peroxide with aldehydes. The kinetics of the reactions of hydrogen peroxide with formaldehyde, deuterated formaldehyde acetaldehyde, and chloral were examined in aqueous solution. Rate constants and equilibrium constants are given for the respective decompositions and formations of the methylene hydroxyperoxide-type intermediates proposed to exist in the reactions of $H_2O_2$ with aldehydes. GRA

**N89-17643#** Missouri Univ., Columbia. Dept. of Physics and Astronomy.
**IN-SITU INFRARED SPECTROSCOPY OF THIN FILMS AND LIQUIDS ON SOLID SURFACES**
J. L. Wragg, H. W. White, and L. F. Sutcu 25 Mar. 1988 7 p
(Contract DAAG29-84-K-0193)
(AD-A201020; ARO-21579.2-MS) Avail: NTIS HC A02/MF A01 CSCL 20E

In-Situ molecular vibrational spectra of thin films and liquids and their interactions with solid surfaces are being measured with a newly constructed tunable diode laser infrared spectrometer. The general techniques of infrared reflection absorption spectroscopy are employed using polarization modulation to reduce the technique to a single beam, single pass method. A discussion of the current and potential uses of the instrument is presented as well as results for some systems currently under study, primarily naturally oxidized aluminum in the presence of pyridine and aluminum with thin anodically deposited layers. GRA

**N89-17644#** Brigham Young Univ., Provo, UT. Dept. of Chemistry.
**SUPERCRITICAL FLUID CHROMATOGRAPHY/SUPERSONIC JET SPECTROSCOPY Progress Report, 1 Jun. - 30 Nov. 1988**
S. R. Goates and M. L. Lee 1988 8 p
(Contract DE-FG22-86PC-90534)
(DE89-004705; DOE/PC-90534/11) Avail: NTIS HC A02/MF A01

We have tested the high pressure sheath nozzle extensively, and used it successfully for capillary supercritical fluid chromatography (SFC) with supersonic jet (SJ) spectroscopy. Sensitive and selective detection of perylene and benzo(a)pyrene in a coal tar (NBS 1597) was achieved. Work on the pulsed direct nozzle has been less successful. As described below, one design of the nozzle has been abandoned, but another potentially promising design has emerged in its place. DOE

**N89-18319*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**SOIL DEVELOPMENT AND SAMPLING STRATEGIES FOR THE RETURNED MARTIAN SURFACE SAMPLES**
Everett K. Gibson *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 86-87 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

**N89-18329*#** Geological Survey, Reston, VA.
**ORGANIC AND INORGANIC GEOCHEMISTRY OF SAMPLES RETURNED FROM MARS**
R. K. Kotra and R. G. Johnson *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 106-107 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

**N89-18330*#** Academy of Sciences (USSR), Moscow. Inst. of Geochemistry and Analytical Chemistry.
**THE STRUCTURE OF THE MARTIAN CRYOLITHOSPHERE UPPER LEVELS Abstract Only**
R. O. Kuzmin, N. N. Bobina, E. V. Zabalueva, and V. P. Shashkina *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 108 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

**N89-18348*#** Osmania Univ., Hyderabad (India). Dept. of Geology.
**DEGASSING HISTORY OF MARS FROM MARTIAN ATMOSPHERE SAMPLES Abstract Only**
A. S. P. Rao *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 142 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

**N89-18356*#** Glasgow Univ. (Scotland). Dept. of Civil Engineering.
**SOIL MICROSTRUCTURE AND ELECTRON MICROSCOPY**
P. Smart and J. R. Fryer *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 158-159 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

**N89-18359*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**EXPERIMENTAL SIMULATIONS OF OXIDIZING CONDITIONS AND ORGANIC DECOMPOSITION ON THE SURFACE OF MARS Abstract Only**
C. R. Stoker, Rocco L. Mancinelli, and Christopher P. McKay *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 163 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

**N89-18362*#** Geological Survey, Denver, CO.
**U-Th-Pb, Sm-Nd, Rb-Sr, AND Lu-Hf SYSTEMATICS OF RETURNED MARS SAMPLES**
M. Tatsumoto and W. R. Premo *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 167-168 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

**N89-18368*#** Open Univ., Milton (England). Dept. of Earth Sciences.
**STABLE ISOTOPIC STUDIES OF H,C,N,O AND S IN SAMPLES OF MARTIAN ORIGIN**
I. P. Wright and C. T. Pillinger *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 179-180 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

# 26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

**N89-17645#** Los Alamos National Lab., NM.
**SURFACE MECHANICAL PROPERTIES OF Ti ALLOYS PRODUCED BY EXCIMER LASER MIXING OF Ti ON AISI 304 STAINLESS STEEL**
T. R. Jervis, J. P. Hirvonen, M. Nastasi, T. G. Zocco, J. A. Martin, G. M. Pharr, and W. C. Oliver 1988 7 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 28 Nov. 1988 Submitted for publication
(Contracts W-7405-eng-36; DE-AC05-76OR-00033; DE-AC05-84OR-21400)
(DE89-000333; LA-UR-88-3036; CONF-881155-4) Avail: NTIS HC A02/MF A01

We have investigated the properties of surface alloys of Ti formed by excimer laser melting and mixing of Ti overlayers on AISI 304 stainless steel substrates. The thickness of the initial Ti surface layers and the fluence and number of pulses used to mix the surface were varied to investigate a broad range of processing conditions. Samples were uniformly translated at different speeds under repetitive pulses of homogenized laser radiation at 308 nm to vary the number of pulses incident on the sample. We investigated the surface structure and composition, the wear and friction behavior, and the surface hardness of the resulting alloys. The extent of mixing is observed by Rutherford backscattering spectroscopy to be proportional to the number of pulses incident on the sample. Amorphous surface layers are formed at some mixing levels with a composition which indicates that Ti substitutes for Fe in the stainless steel on a one to one basis. Incorporation of C from surface and interface contamination is observed but at a level much below that found in comparable ion implanted materials. Friction coefficient measurements indicate that there exists an optimum level of mixing for each layer thickness. DOE

**N89-17646#** Korea Advanced Energy Research Inst., Seoul (South Korea). Dept. of Materials Science.
**DEFORMATION AND FRACTURE OF W-Ni-Fe HEAVY ALLOYS Ph.D. Thesis**
Kil-Sung Churn 1988 115 p
(Contract DE-AC05-84OS-21400)
(DE88-012779; Y/TR-88/1) Avail: NTIS HC A06/MF A01

Investigations were carried out not only into the effects of composition but also into the effects of particle size, sintering temperature, and sintering time on the plastic deformation and fracture of W--Ni--Fe heavy alloys. The change in the microstructure of heavy alloys with different sintering conditions was also examined. The plastic deformation and fracture behaviors of alloys of different compositions were also studied and compared with the results of the microstructure study. The ratio of Ni/Fe was set at a constant value 1/1, which was known to be the best optimum value. The concentration of tungsten was varied from 90 to 98 w/o as in commercial materials. DOE

**N89-17647#** Japan Atomic Energy Research Inst., Tokyo. Dept. of Engineering Service.
**DEVELOPMENT OF NIOBIUM ALLOY/STAINLESS STEEL JOINT BY FRICTION WELDING, (1)**
Taiji Kikuchi and Hiroshi Kawamura Aug. 1988 36 p In JAPANESE; ENGLISH summary
(DE88-755524; JAERI-M-88-150) Avail: NTIS (US Sales Only) HC A03/MF A01

The niobium alloy and stainless steel have been jointed by the nicrobrazing method generally. However the strength of the jointed part is weaker than that of the mother material. Therefore we developed the niobium alloy (Nb-1 percent Zr) stainless steel (SUS 304) transition joint by the friction welding method. We conducted the mechanical tests (tensile test at room temperature, 300 C, 500 C and 700 C, torsion fatigue test and burst test), metallographical observation and electron prove X-ray microanalysis observation. Those tests proved jointed part by the friction welding had enough properties for general uses. DOE

**N89-17648#** Boston Univ., MA. Dept. of Physics.
**ATOMIC BEAM STUDIES OF THE INTERACTION OF HYDROGEN WITH TRANSITION METAL SURFACES Technical Progress Report, 1 Aug. 1985 - 1 Sep. 1988**
1988 22 p
(Contract DE-FG02-85ER-45222)
(DE89-005256; DOE/ER-45222/T1) Avail: NTIS HC A03/MF A01

This paper discusses the interactions of helium beams with metal surfaces. Particular topics covered are: improvement in He scattering facilities; spin polarized metastable He beam---a new probe of surface magnetism; and molecular dynamics simulations of the structure and dynamical properties of Cu, Ag and Au surfaces. DOE

**N89-17649*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**TENSILE BEHAVIOR OF TUNGSTEN AND TUNGSTEN-ALLOY WIRES FROM 1300 TO 1600 K Final Report**
Man Yun Hee Sep. 1988 18 p Presented at the Metallurgical Society Fall Meeting, Chicago, IL, 27-29 Sep. 1988; sponsored in part by The Metallurgical Society of AIME, and the American Society for Metals
(Contract DE-AI03-86SF-16310)
(NASA-TM-101446; E-4552; NAS 1.15:101446; DOE/NASA/16310-7) Avail: NTIS HC A03/MF A01 CSCL 11F

The tensile behavior of a 200-micrometer-diameter tungsten lamp (218CS-W), tungsten + 1.0 atomic percent (a/o) thoria (ST300-W), and tungsten + 0.4 a/o hafnium carbide (WHfC) wires was determined over the temperature range 1300 t0 1600 K at strain rates of 3.3 X 10 to the -2 to 3.3 X 10 to the -5/sec. Although most tests were conducted on as-drawn materials, one series of tests was undertaken on ST300-W wires in four different conditions: as-drawn and vacuum-annealed at 1535 K for 1 hr, with and without electroplating. Whereas heat treatment had no effect on tensile properties, electropolishing significantly increased both the proportional limit and ductility, but not the ultimate tensile strength. Comparison of the behavior of the three alloys indicates that the HfC-dispersed material possesses superior tensile properties. Theoretical calculations indicate that the strength/ductility advantage of WHfC is due to the resistance to recrystallization imparted by the dispersoid. Author

**N89-17650*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**SECONDARY ELECTRON EMISSION CHARACTERISTICS OF UNTREATED AND ION-TEXTURED TITANIUM**
Arthur N. Curren, Kenneth A. Jensen, and Gary A. Blackford (Case Western Reserve Univ., Cleveland, OH.) Mar. 1989 16 p
(NASA-TP-2902; E-4495; NAS 1.60:2902) Avail: NTIS HC A03/MF A01 CSCL 11F

Experimentally determined values of true secondary electron emission and relative values of reflected primary electron yield are presented for untreated (simply machined) and ion-textured, high-purity titanium over ranges of primary electron beam energies and beam impingement angles. The purpose of the investigation was to explore the feasibility of using titanium as electrode material in the multistage depressed collectors (MDC's) used in microwave amplifier traveling wave tubes (TWT's) for space communications and aircraft applications. Because of its relatively low density and thermal expansion characteristics and relatively high strength, thermal emissivity, and melting temperature, titanium presents itself as a possible candidate for the MDC electrode application. A detailed description of the method of ion texturing the titanium is included. Although the ion-treated surface considered in this study is not presented as being optimum from the standpoint of secondary electron emission suppression, it nevertheless serves to demonstrate that the surface can be modified by this procedure to significantly reduce these emission characteristics relative to those of the untreated surface. Further studies can reasonably be expected to produce surfaces with even lower secondary emission characteristics. The titanium surface were tested at primary electron beam energies of 200 to 2000 eV and at direct (0 deg) to near-grazing (85 deg) beam impingement angles. True secondary electron emission and relative reflected primary electron yield characteristics of the surfaces were compared with each other and with textured titanium surface exhibited secondary electron emission characteristics sharply lower than those exhibited by untreated titanium or copper. Clearly, then, in consideration of the secondary electron emission suppression of ion-textured titanium along with its other favorable physical properties, it must be included as a potential candidate for use as MDC electrode material in some applications. Author

**N89-17651#** Etablissement Technique Central de l'Armement, Arcueil (France). Service Chimie-Physique.
**CONTRIBUTION OF ELECTROCHEMICAL AND RADIOCHEMICAL METHODS TO THE STUDY OF THE CORROSION OF PAINTED XC38 STEEL [CONTRIBUTION DES METHODES ELECTROCHIMIQUES ET RADIOCHIMIQUES A L'ETUDE DE LA CORROSION DE L'ACIER XC38 PEINT]**
N. Celati and G. Geffroy 3 Jul. 1987 63 p In FRENCH
(Contract DRET/SDR-82-1287)
(ETCA-87-R-65; ETN-89-94092) Avail: NTIS HC A04/MF A01

Corrosion kinetics studies were carried out by immersion of surface treated specimens in ClNa and Na2SO4 solutions. The parameters deduced from the electrochemical impedance measurement are compared to those obtained by means of radio tracers. The corrosion velocity is quantitively related to the electrochemical impedance measurement. An expression determining corrosion as a function of immersion time, coating thickness and metal/electrolyte interface is presented. ESA

**N89-17652#** Institut National des Sciences Appliquees, Lyon (France). Groupe d'Etudes de Metallurgie Physique et de Physique des Materiaux.
**STUDY OF LEARNING TREATMENTS, STABILITY AND ORIGIN OF TWO WAY SHAPE MEMORY IN CuZnAl ALLOY Ph.D. Thesis [ETUDE DES TRAITEMENTS D'EDUCATION, DE LA STABILITE ET DE L'ORIGINE DE L'EFFET MEMOIRE DE FORME DOUBLE SENS DANS UN ALLIAGE CU-ZN-AL]**
Laurent Contardo 1988 133 p In FRENCH
(ISAL-88-0048; ETN-89-94102) Avail: NTIS HC A07/MF A01

Experimental devices were developed to study the learning treatment used to obtain the reversible shape memory effect. The type of cycles studied included a transformation with constant stress and the use of the superelastic effect for temperatures larger than a threshold. Results show that it is possible to predict the temperature-deformation curve from the learning treatment. Over 100 C, a continuous loss of two way effect is observed and related to a diffusional process with an apparent activation energy of 1.21 eV. It is suggested that the two way shape memory effect is due to dislocations created during the learning process, either by sliding under stress or by progression of the Martensitic transformation. ESA

**N89-17653#** Institut National des Sciences Appliquees, Lyon (France).
**EROSION BY SOLID PARTICLES IN A LASER TREATED TA6V TITANIUM ALLOY Ph.D. Thesis [COMPORTEMENT A L'EROSION PAR DES PARTICULES SOLIDES D'UN ALLIAGE DE TITANE TA6V TRAITE PAR LASER]**
Jean-Paul Massoud 1988 173 p In FRENCH Original contains color illustrations
(ISAL-88-0057; ETN-89-94103) Avail: NTIS HC A08/MF A01

The study of the erosion damage of the TA6V alloy leads to a description based on micromachining and plastic fatigue. The effect of structural parameters is explored. The laser surface treatment allowed the study of erosion behavior of different protective processes such as nitriding and boron nitriding. The structure of these layers is described. The erosion resistance and the matter loss mechanisms are detailed. ESA

**N89-17654#** Argonne National Lab., IL.
**INITIAL ASSESSMENT OF THE PROCESSES AND SIGNIFICANCE OF THERMAL AGING IN CAST STAINLESS STEELS**
O. K. Chopra and H. M. Chung Oct. 1988 39 p Presented at the 16th Water Reactor Safety Information Meeting, Gaithersburg, MD, 24 Oct. 1988
(Contract W-31-109-eng-38)
(DE89-003633; CONF-8810155-22) Avail: NTIS HC A03/MF A01

Charpy-impact and J-R curve data for thermally aged cast stainless steel are presented. The effects of material variables on the embrittlement of cast materials are evaluated. The chemical composition and ferrite morphology have a strong effect on the

kinetics and extent of embrittlement. The procedure and correlations for predicting the impact strength and fracture toughness of cast component during reactor service are described. DOE

**N89-17655#** Naval Research Lab., Washington, DC. Materials Science and Technology Div.
**DETERMINATION OF DUCTILE ALLOY CONSTITUTIVE RESPONSE BY ITERATIVE FINITE ELEMENT AND LABORATORY VIDEO IMAGE CORRELATION**
P. Matic, G. C. Kirby, III, M. I. Jolles, and P. R. Father (Geo-Centers, Inc., Fort Washington, MD.) 9 Aug. 1988 62 p
(RR0220148)
(AD-A200617; NRL-MR-6233) Avail: NTIS HC A04/MF A01 CSCL 14B

The accurate description of material response consists of a material constitutive formulation and material parameter values. The reduction of material test specimen load versus displacement data to constitutive parameters is often precluded by inelastic material response and deformation inhomogeneity within the specimen. For ductile engineering alloys, these effects are influenced by specimen geometry and must be uncoupled from specimen geometry to characterize the large strain material response. The accuracy of material parameters at such strains should be demonstrated for subsequent applications to design and analysis. Iterative solution for material constitutive parameters is discussed in the investigation. The use of video image processing of laboratory tensile test specimens is combined with successive computational simulations of the specimen responses. The solution for HSLA-80 steel constitutive parameters, in the context of incremental plasticity theory, is presented. The material response is treated as the unknown in the computational simulations. It is iteratively modified to achieve correlation with the laboratory experiments. Two different specimen length-to-diameter aspect ratios are utilized to ensure the geometry independence of the material solution and to facilitate efficient solution. The constitutive iteration sequence illustrates the sensitivity of specimen response to material nonlinearity. GRA

**N89-17656#** Lawrence Livermore National Lab., CA. Chemistry and Materials Science Dept.
**ELECTRON MICROSCOPY AND NEUTRON SCATTERING STUDIES OF PREMARTENSITIC BEHAVIOR IN ORDERED Ni-Al BETA(2) PHASE**
D. Schryvers, L. E. Tanner, and S. M. Shapiro (Brookhaven National Lab., Upton, NY.) 1988 8 p Presented at the MRS International Meeting on Advanced Materials, Tokyo, Japan, 30 May 1988
(Contracts DE-AC02-76CH-00016; W-7405-eng-48)
(DE89-005645; BNL-41957; CONF-880529-8) Avail: NTIS HC A02/MF A01

High-resolution electron microscopy and elastic and inelastic neutron scattering examinations of the beta 2 (B2) phase of Ni62.5Al37.5 show a direct relationship between the evolution of premartensitic structural configurations and anamalous changes in lattice dynamical behavior as the beta 2 cools toward its martensitic transformation temperature, M sub s. The resulting microstructure is a fine-scale mosaic assembly of nonuniformly distorted and modulated domains, in which (110) shear-plus-shuffle displacements five rise to the (110) B2 micromodulations of approx. 1.3 nm wavelength. These displacements are derived from the unusually low energy of the sigma sub 4 /zeta/zeta/O minus TA sub 2 phonon mode and its anomalous temperature dependent incomplete softening at zeta = O (viz., the elastic constant C') and at zeta approx. 0.16. The domains (dressed embryos in Yamada's terminology) are viewed as the precursors to nucleation of the product 7R(52) martensite; the way this transformation process is facilitated, however, is still a problem to be solved. DOE

# 27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials.*

**N89-17657#** Los Alamos National Lab., NM.
**POLY(VINYL PYRIDINE)-BASED STABILIZERS FOR AQUEOUS POLYPYRROLE LATICES**
Steven P. Armes, Mahoud Aldissi, and Stephen F. Agnew 1988 12 p Presented at the ICSM '88, Santa Fe, NM, 25 Jun. 1988
(Contract W-7405-eng-36)
(DE88-016219; LA-UR-88-2705; CONF-8806264-1) Avail: NTIS HC A03/MF A01

The preparation and characterization of sub-micronic polypyrrole latex particles using polymeric stabilizers based on poly(vinyl pyridine) is described. These novel colloidal dispersions enhance the usually limited processability of the electroactive component, and in addition exhibit usefully high solid-state conductivity, despite the presence of the insulating stabilizer component. Furthermore, these latices exhibit reversible base/acid induced flocculation-stabilization behavior. The latter phenomenon is of fundamental interest and is expected to have commercial applications. The latices were characterized by transmission electron microscopy, visible absorption spectroscopy, FTIR and Raman spectroscopy, microanalysis, and compressed pellet dc conductivity. Base-induced particle flocculation was studied as a function of latex particle concentration. DOE

**N89-17658#** California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Chemical Sciences Div.
**CHARACTERIZATION OF NEWLY SYNTHESIZED NOVEL GRAPHITE FILMS**
Kannan M. Krishnan, John Kouvetakis, Takayoshi Sasaki, and Neil Bartlett May 1988 8 p Presented at the Spring Meeting of the Materials Research Society, Reno, NV, 4 Apr. 1988
(Contract DE-AC03-76SF-00098)
(DE89-001261; LBL-25067; CONF-880408-40) Avail: NTIS HC A02/MF A01

Reactions of C6H6 and BCl3 at 800 C yields a metallic graphite-like material of composition BC sub x (3.0 less than or equal to x less than or equal to 4.00) while reactions of BCl3, NH3 and C2H2 produces a B/C/N graphitic semiconductor of approximate stoichiometry B2CN2. Both materials were shown to be homogeneous using Auger electron spectroscopy and extensively characterized by electron energy-loss spectroscopy. Single loss profiles of the EELS data were obtained using the fourier-log deconvolution method. Compositions were determined using hydrogenic cross-sections. A careful study of the plasmon resonance energies and the fine structures of the core-loss edges of these materials has been invaluable in demonstrating that the boron, carbon and nitrogen atoms are all $sp^2$ hybridized. Therefore, these new materials are in-sheet graphite hybrids and not intercalations. DOE

**N89-17659#** Oak Ridge National Lab., TN. Metals and Ceramics Div.
**WHISKER REINFORCED CERAMICS: TOUGHENING BEHAVIOR AND PROPERTIES**
Paul F. Becher, Peter Angelini, Chun-Way Hsueh, and Terry N. Tiegs 1988 28 p Presented at the 7th International Symposium on Ceramics, Bologna, Italy, 14 Dec. 1988
(Contract DE-AC05-84OR-21400)
(DE89-004181; CONF-881207-1) Avail: NTIS HC A03/MF A01

Several whisker reinforced ceramics exhibit considerably enhanced toughness which is derived from strong bridging whiskers in the crack tip region. Theoretical analyses of crack bridging by whiskers shows that the composite's toughness increases with whisker strength, radius, and volume content, the ratio of the fracture energy of the matrix to that of the whisker-matrix interface, and the ratio of the Young's modulus of the composite to that of the whisker. These features have been confirmed by a variety of experimental results. The observed lack of a temperature

dependence for the toughness suggests whisker reinforcement as a most effective means of toughening ceramics. Also in comparison to equiaxed and plate like particles, toughening by whisker additions exhibit both greater fracture toughness and strength. Finally as compared to monolithic ceramics, various other mechanical properties are also significantly improved in the whisker reinforced ceramics. DOE

**N89-17660#** Pacific Northwest Labs., Richland, WA.
**GAMMA-RAY ATTENUATION ANALYSIS OF PACKING STRUCTURE EVOLUTION DURING POWDER CONSOLIDATION**
C. H. Schilling and Ilhan A. Aksay (Washington Univ., Seattle.) Feb. 1988 10 p Presented at the 1st International Conference on Ceramic Powder Processing Sciences, Orlando, FL, 1 Nov. 1987 Submitted for publication
(Contract DE-AC06-76RL-01830)
(DE88-007840; PNL-SA-15087; CONF-8711115-6) Avail: NTIS HC A02/MF A01

Gamma-ray attenuation measurements enable nondestructive analysis of powder packing density heterogeneities which develop during consolidation of ceramic compacts. In situ measurements of gamma-ray attenuation were performed during sedimentation of aqueous alumina suspensions to evaluate the role of suspension pH on particle rearrangement processes in cast layers. These data are used to support consolidation kinetic models describing processes of agglomerate restructuring and cast layer compaction. Porosity defects in sintered casts are correlated with pH-dependent processes of pore closure detected during sedimentation. DOE

**N89-17661#** Technische Hochschule, Darmstadt (Germany, F.R.).
**THERMODYNAMICS AND DYNAMICS OF POLYMER BLENDS Ph.D. Thesis [THERMODYNAMIK UND DYNAMIK VON POLYMER-LEGIERUNGEN]**
Ruediger Wilhelm Garbella 1987 157 p In GERMAN
(ETN-89-93495) Avail: NTIS HC A08/MF A01

The thermodynamic and dynamic quantities which control structure formation in blends of compatible polymers were characterized, using the model system polyvinyl fluoride/ polyethylene acrylate (PVF/PEA). A differential calorimetric method was developed for the measurement of the mixing enthalpy which determines mainly the thermodynamics of polymer blends. The measured separation heat, which allows the determination of the enthalpic part of the interaction parameters, shows a pronounced concentration dependence which is confirmed by computer simulations. The growth of the separated structure can be described by a modified nucleation theory. A method was developed for the measurement of the interdiffusion; the results can only be described by the von Brochard model. It is shown that the dynamics are strongly determined by the thermodynamics of the blend. ESA

**N89-17662#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Physik.
**POLYMER LIQUID CRYSTALS: PROPERTIES OF MONODOMAINS Ph.D. Thesis [POLYMERE FLUESSIGKRISTALLE: EIGENSCHAFTEN VON MONODOMAENEN]**
Manfred Eich 1987 213 p In GERMAN
(ETN-89-93510) Avail: NTIS HC A10/MF A01

Monodomains consisting of polymer side-chain liquid crystals were investigated with a view to anisotropic physical properties and macroscopic orientation states. Two relaxation processes are spectroscopically found for anisotropic coupling of the molecule to an external electric field. The temperature dependence of these processes was determined. The characterization of the monodomains using optical methods shows that the anisotropic diffraction index and the dichroism are sensitive measuring quantities for phase transitions and orientation ordering state. The influence of single electronic bindings on the macroscopic anisotropic optical properties is clear. The anisotropy of thermally induced isomerization allows the characterization of reorientations due to radiation. A method to vary the orientation order in monodomains was developed; examples of possible applications are given. ESA

**N89-17663#** Royal Aerospace Establishment, Farnborough (England).
**CALCULATION OF THE GLASS TRANSITION TEMPERATURES OF LINEAR POLYMERS. PART 2: THE POLYMER DATA SET**
W. A. Lee Apr. 1988 147 p
(RAE-TR-88028; RAE-MAT-STR-223; BR107360; ETN-89-93674; AD-A200495) Copyright Avail: Defence Research Information Centre, 65 Brown Street, Glasgow G2 8EX, Scotland

A data set of 1179 polymers, with corresponding glass transition temperatures, is tabulated in the form of chemical structures and in numerical form suitable for computer analysis. Polymers were analyzed into groups with invariant nearest neighbors and where a particular group is found on only one polymer, it is identified. An unambiguous and easily assimilated method of analyzing and classifying polymer structures into combinations of groups is illustrated. It is suggested that the polymer data set, with appropriate modifications and improvements, should be used as a standard set for the evaluation of Tg relationships. ESA

**N89-17664** National Physical Lab., Teddington (England). Div. of Materials Applications.
**THE USE OF PLATE BENDING WAVES FOR ELASTIC PROPERTY DETERMINATION OF POLYMERS**
G. D. Dean Aug. 1988 28 p
(NPL-DMA(A)166; ISSN-0143-7313; ETN-89-93710) Copyright Avail: National Physics Laboratory, Teddington, Middlesex, TW11 0LW, United Kindgom

A method for determining elastic properties of reinforced and isotropic plastics through measurement of the velocity of plate bending (Lamb) waves of frequency around 100 kHz is described. The method is applicable to test pieces or fabricated articles in the form of a plate or shell of uniform thickness. Lamb waves may be launched and received at a single surface and travel with a velocity which is sensitive to in-plane tensile properties. There is therefore scope for using the method nondestructively for measuring the tensile stiffness in the direction of reinforcement in fiber reinforced plastics. The capabilities and limitations of the technique are demonstrated through measurements made on unreinforced plastics, an aligned carbon fiber reinforced material, and two carbon fiber reinforced cross-ply laminates. ESA

**N89-17665#** Oak Ridge National Lab., TN.
**MICROSTRUCTURE EVOLUTION IN MICROWAVE SINTERED ALUMINA**
Mark A. Janney and Hal D. Kimrey 1988 12 p Presented at the 90th Annual Meeting of American Ceramic Society, Cincinnati, OH, 1 May 1988
(Contract DE-AC05-84OR-21400)
(DE89-004186; CONF-880504-9) Avail: NTIS HC A03/MF A01

Comparisons were made of sintering rate, apparent activation energy, surface area, and pore size distribution for alumina sintered in a quasi-optical microwave furnace at 28 GHz and alumina sintered in a conventional tungsten element furnace. The sintering rates for microwave firing were much higher. The apparent activation energy for microwave sintering was about one-third that of conventional sintering. Pore size at a given density was larger for the microwave sintered samples. It is suggested that microwave firing may enhance densification relative to coarsening in sintering. DOE

**N89-17666#** Mound Lab., Miamisburg, OH.
**CHEMISTRY OF GLASS-CERAMIC TO METAL BONDING FOR HEADER APPLICATIONS. PART 4: EFFECT OF TREATMENTS ON MULTICOMPONENT LITHIA/ALUMINA/SILICA GLASS-CERAMIC**
Daniel P. Kramer and William E. Moddeman 30 Nov. 1988 23 p

(Contract DE-AC04-88DP-43495)
(DE89-004432; MLM-3556) Avail: NTIS HC A03/MF A01

Auger Electron Spectroscopy (AES) and Electron Spectroscopy for Chemical Analysis (ESCA) were used to study the surface of a multicomponent lithia/alumina/silica glass-ceramic as a function of surface treatment. The glass-ceramic specimens were processed in the same manner as is presently being used in the manufacturing of glass-ceramic headers. The processing steps involve four-step solvent cleaning, sealing at high temperature, and oxide removal. At each step in the process, glass samples were studied with AES and ESCA to determine their resultant elemental surface composition and film thickness. In addition, the effect of a final plasma cleaning operation on the glass surface was also examined. The results show that the type, concentration, and thickness of surface species are dependent on the processing technique. DOE

**N89-17667#** Allied-Signal Aerospace Co., Kansas City, MO.
**PROCESS CHARACTERIZATION OF MOLDED LOW DENSITY URETHANE FOAM**
D. R. Watson Dec. 1988 18 p
(Contract DE-AC04-76DP-00613)
(DE89-004436; KCP-613-4037) Avail: NTIS HC A03/MF A01

Low density molded-to-size polyurethane foam parts have had historically low production yields compared with polyurethane products with higher densities. Low density products are more difficult to produce because of the larger volumetric expansion that is required. This additional expansion makes the product more sensitive to processing parameters and more likely to contain surface and internal voids. A designed experiment was formulated to determine how changes in the process variables affect the size and location of internal and surface voids. The part chosen for this study is a low density (0.16 g/cm$^3$) thin-walled (cross section less than 0.35 in.) foam support. The process parameters chosen for this investigation included pour pattern, mold position, mold preheat, mixing speed, R and T component temperatures, and material dispense rate. DOE

**N89-17668*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**DYNAMIC POROSITY VARIATIONS IN CERAMICS**
Edward R. Generazio, David B. Stang (Sverdrup Technology, Inc., Cleveland, OH.), and Don J. Roth Dec. 1988 7 p
(NASA-TM-101340; E-4358; NAS 1.15:101340) Avail: NTIS HC A02/MF A01 CSCL 11B

A silicon carbide disk was sintered from 2090 to 2190 C in 25 C steps. After each sintering step the disk was examined using a precision acoustic scanning system to determine acoustic attenuation and velocity. The bulk density was found to vary nonmonotonically with sintering temperature. During the sintering process, the density varied as much as 10 pct from its value at 2090 C. Local density fluctuations were observed to occur in an organized and history-dependent way. These local density fluctuations varied up to + or - 7 pct of the bulk density and were made visible by acoustic attenuation and velocity mapping. Author

**N89-17669#** Akron Univ., OH. Inst. of Polymer Science.
**DIFFUSION OF LINEAR POLYISOPRENE MOLECULES INTO POLYISOPRENE NETWORKS**
A. N. Gent and S. Y. Kaang Oct. 1988 52 p
(Contract N00014-85-K-0222)
(AD-A200668; TR-16) Avail: NTIS HC A04/MF A01 CSCL 07F

Diffusion and equilibrium absorption of polyisoprene liquids into crosslinked samples of cis-polyisoprene (natural rubber) have been studied by direct observation of volume swelling. Natural rubber was crosslinked in the form of fine threads, about 40 + or - 20 micrometers in diameter, using a gaseous reaction with sulfur dioxide and hydrogen sulfide (the Peachey process). An optical microscope was used to observe the relatively rapid absorption of linear high-molecular-weight polyisoprene liquids by these fine threads. From the kinetics of absorption, values of the self-diffusion coefficient of polyisoprene were estimated. Amounts of polymer absorbed at equilibrium varied widely, depending upon the degree of crosslinking of the host material and the molecular weight of the absorbing liquid. They were in reasonable agreement in all cases with simple swelling theory, with the heat of mixing equated to zero. GRA

**N89-17670#** Cincinnati Univ., OH. Dept. of Materials Science and Engineering.
**STRUCTURE AND PROPERTIES OF POLYMER INTERPHASES Annual Report No. 3, 1 Jul. 1987 - 30 Jun. 1988**
F. James Boerio 30 Sep. 1988 38 p
(Contract N00014-85-R-0459)
(AD-A200669) Avail: NTIS HC A03/MF A01 CSCL 07C

The molecular structure of interphases between polymer systems and metal substrates was determined by using X-ray photoelectron spectroscopy (XPS), reflection absorption infrared spectroscopy (RAIR), and attenuated total reflection infrared spectroscopy (ATR) to characterize the failure surfaces of double cantilever beam adhesive joints prepared by curing beams of epoxies against metal beams. The structure of the interphases depended strongly on the curing agent, metal substrate, and use of a silane primer on the substrate. When joints were prepared by curing an epoxy with a tertiary amine curing agent at 75 C against a steel substrate primed with a dilute aqueous solution of y-aminopropyltriethoxy-silane (gamma-APS), there was little reaction between the primer and adhesive and failure occurred near the primer/adhesive interface. The interphase consisted of low molecular weight siloxane oligomers in which the amino groups formed bicarbonates with water and carbon dioxide absorbed from the atmosphere. GRA

**N89-17671#** Colorado School of Mines, Golden. Center for Welding Research.
**INVESTIGATIONS INTO THE INFILTRATION KINETICS AND INTERFACIAL BOND STRENGTH OF Al/SiC COMPOSITES Annual Report**
Steven Fishman, Glen R. Edwards, and David L. Olson Jul. 1988 49 p
(Contract N00014-88-K-0500)
(AD-A200752; CSM-MT-CWR-088-022) Avail: NTIS HC A03/MF A01 CSCL 11D

The work for this project is continuing in the following two areas: (1) isothermal infiltration into porous compact and tube bundles or capillaries, and (2) a fundamental study of bonding at the metal ceramic interface. In a continuing effort to understand the fundamental nature of the aluminum silicate interface, a technique for determining properties at the metal/ceramic interface was proposed. The model provides a method for predicting interfacial properties from the measured optical properties of the metal and ceramic surfaces. GRA

**N89-17672#** Utah Univ., Salt Lake City. Dept. of Chemistry.
**MATHEMATICAL MODELLING OF TRANSPORT THROUGH CONDUCTING POLYMER FILMS. PART 1: THE POLY(PARAPHENYLENE) SYSTEM Technical Report No. 106, Sep. 1987 - Jul. 1988**
Kevin Ashley, Stanley Pons, and Martin Fleischmann 15 Jul. 1988 24 p
(Contract N00014-83-K-0470)
(AD-A200842) Avail: NTIS HC A03/MF A01 CSCL 07F

Modeling studies concerning charge transport through organically conductive polymer systems have focussed principally on poly(acetylene) (PA) and poly(pyrrole) (PP) with charge transport presumed to occur via polarons, bipolarons, or charged solitons, depending on the system. Apart from theoretical studies on organic conducting polymers, a significant amount of theoretical work has been done in efforts to explain transport phenomena in electrodes modified with inorganic conducting systems such as poly(vinylferrocene) (PVC) and other transition metal-containing polymers. To date these theoretical models have been for the most part quantum mechanical in nature, with transport presumed to occur via an electron hopping mechanism. GRA

**N89-17673#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH.
**HIGH MOLECULAR WEIGHT POLYPHENYLQUINOXALINES WITH INCREASED SOLVENT RESISTANCE Final Report, Apr. 1983 - Mar. 1985**
Patricia M. Lindley, Bruce A. Reinhardt, and Fred A. Arnold Sep. 1988 55 p
(AD-A200997; AD-E501032; AFWAL-TR-88-4198) Avail: NTIS HC A04/MF A01 CSCL 07F

Biphenyl-based bisbenzilmonomers which contain pendant phenylethynyl groups in the 2,2' positions are condensed with 3,3'- diaminobenzidine to make polyphenylquinoxalines (PPQS). Thermal cure of these polymers cause an intramolecular cyclization (TMC) of the phenylethynyl groups to give the rigid 9-phenyldibenzathracene system in the backbone of the polymer. The initial, uncured polymers form tough films which are soluble in m-cresol and chlorinated solvents, but after thermal cure the films become insoluble in all common organic solvents and acids while maintaining their toughness. Scans of the cured materials showed small residual exotherms indicating that after vitrification even the intramolecular rotation required for the IMC reaction becomes restricted. GRA

**N89-17674#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH.
**SYNTHESIS AND THERMAL PROPERTIES OF ARYL AND ARYLOXYETHYNYL MONOMERS FOR THERMOSET RESINS OF REDUCED CROSSLINK DENSITY Final Report, May 1982 - Oct. 1984**
Marilyn R. Unroe, Bruce A. Reinhardt, and Fred E. Arnold Sep. 1988 47 p
(AD-A201047; AFWAL-TR-88-4197) Avail: NTIS HC A03/MF A01 CSCL 11I

A series of thermoset matrix materials with phenylethynyl and pheno yphenylethynyl end groups were presented to assess the extent of crosslinking in the cured resins by thermo-analytical and thermomechanical methods. These novel materials with varying flexibility and thermal stability of both the end group and backbone were evaluated against a group of materials (AT systems) known to contain a substantial number of primary acetylenic thermal crosslinking sites. The evaluation indicated the increased thermooxidative stability of the secondary acetylenic materials over the AT systems at or below 600 F (312 C). However, above 600 F the reverse observation was true since the phenyl pendant of the secondary termini was thermally decomposed near 400 C (752 F) as measured by MS/TGA under vacuum. Cure exotherms (T poly) for monomers exhibited typical Gaussian behavior with discernable cure onsets and maxima. GRA

**N89-17675#** California Univ., Santa Barbara. Dept. of Materials.
**PARTITIONING REACTIONS TO CONTROL AND DEVELOP UNIQUE MICROSTRUCTURES Annual Report, 15 Jun. 1987 - 14 Jun. 1988**
Fred F. Lange and Manfred Ruehle 31 Jul. 1988 88 p
(Grant AF-AFOSR-0291-87; AF Proj. 2306)
(AD-A201067; AFOSR-88-1016TR) Avail: NTIS HC A05/MF A01 CSCL 11D

Transmission Electron Microscopy (TEM) studies for different zirconium dioxide ceramics are reported. Observations are described to characterize the atomistic defects present in Mg-PSZ. TEM is applied to study phase stability and transformation in Y-TZP. The nucleation of stable m-ZrO2 at stress singularities associated with grain boundaries was studied in situ and related to strains and strain distributions determined by high resolution electron microscopy. The effect of grain growth on the morphological stability of polycrystalline fibers, constrained by a matrix, was determined. Analogous to thin films, grain growth was observed to cause the fiber to break-up into individual grains when the grain size to fiber diameter ratio exceeded a critical value. Calculations show that the free energy of the system continuously decreases as this break-up occurs. These results are important when polycrystalline fibers are intended to reinforce a matrix to produce a stronger composite material, viz., extensive grain growth must be avoided to maintain a fiber morphology within the composite. GRA

**N89-17676#** Idaho National Engineering Lab., Idaho Falls.
**ACOUSTIC-OPTIC MEASUREMENT OF MICROMECHANICAL RESONANCE FOR ADHESIVE BOND INTEGRITY**
B. A. Barna, R. T. Allemeier, J. G. Rodriguez, and D. M. Tow 1988 6 p Presented at the Review of Progress in Quantitative Nondestructive Evaluation, La Jolla, CA, 31 Jul. 1988
(Contract DE-AC07-76ID-01570)
(DE89-005416; EGG-M-88442; CONF-880760-8) Avail: NTIS HC A02/MF A01

Traditional nondestructive evaluation (NDE) of bonding flaws has generally used either ultrasound or X-rays as a directed energy source to image or otherwise detect the discontinuity of an improper bond. While this approach has broad applicability, it is inadequate where the material is highly attenuating or anisotropic, or when it is impossible to achieve an adequate interrogation due to geometrical constraints. These difficulties are seen in materials such as the silica fiber composites used for the thermal protection tiles on the Space Shuttle Orbiter, insulating rubber liners used for solid rocket motors, and rubber or foam coating materials. This paper discusses a method for determining bond condition in these types of materials by exciting the component as a whole and analyzing its micromechanical response. The concept is that the bond region forms a boundary of a physical system whose dynamic response is governed by a deterministic set of equations of motion. As the boundary conditions change, the system response will change. The problem then reduces to verifying that a given dynamic response can be uniquely correlated with a specific bond condition. This approach has a distinct advantage in that it can potentially survey the bond condition of a component or region with a single rapid measurement and provide the basis for a go/no-go decision. DOE

**N89-17677#** Lawrence Livermore National Lab., CA.
**THE PRIME IMPORTANCE OF SECOND-ORDER EFFECTS IN RIGID-ROD POLYMERS**
Steven J. DeTeresa and Richard J. Farris (Massachusetts Univ., Amherst.) 22 Nov. 1988 7 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 28 Nov. - 3 Dec. 1988
(Contract W-7405-eng-48)
(DE89-004809; UCRL-100017; CONF-881155-21) Avail: NTIS HC A02/MF A01

The torsion modulus of high performance rigid-rod polymer fibers is shown to be dependent on axial tensile stress. This behavior is one of at least second-order elasticity. Fiber ultimate tensile strengths are of the same magnitude as torsion moduli, and increases in torsion moduli in excess of 200 percent were observed for fibers under tension. Consideration of the effect of axial compressive stress on fiber torsion modulus leads to a prediction of an elastic shear instability that initiates at a compressive stress approximately equal in magnitude to the zero-stress torsion modulus. Hence, it is concluded that the compressive strengths of high performance polymer fibers are limited by the onset of an elastic microstructural instability. DOE

# 28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

**N89-17678** Vermont Univ., Burlington.
**GEOMETRIC CONSIDERATIONS IN THE IGNITION PROCESS OF SOLID PROPELLANTS: THEORY AND EXPERIMENT Ph.D. Thesis**

Lolke Geert Vorsteveid 1988 230 p
Avail: Univ. Microfilms Order No. DA8816720

The effect of geometry on the ignition behavior of solid propellants was investigated. Physical and mathematical formulations of the theoretical problem are presented, where extensive use is made of the reactive solid concept, with ignition being controlled by a solid phase exothermic chemical reaction. Mathematical equations are described in two different dimensional domains, and solved numerically over a wide range of physico-chemical parameters utilizing the explicit finite difference method. Dissert. Abstr.

**N89-17679#** Iowa State Univ. of Science and Technology, Ames. Dept. of Chemistry and Chemical and Materials Engineering.
**DEHYDROGENATION OF CYCLOALKANES CATALYZED BY METALS IN SUPPORTED MOLTEN SALTS Final Report, 29 Jan. - 12 Dec. 1987**
Darrell P. Eyman and Ravindra Datta 14 Mar. 1988 51 p
(Contract F33615-84-C-2410; AF Proj. 3048)
(AD-A200619; AFWAL-TR-88-2029) Avail: NTIS HC A04/MF A01 CSCL 07C

The studies were designed to evaluate the potential advantages associated with the use of transition metal microcrystallites dispersed in molten salts in the dehydrogenation of cyclic hydrocarbons which are viewed as potential endothermic fuel candidates. Although both molten salt pools and Supported Molten Salt Catalysts (SMSC) were studied, only SMSC gave results which show any developmental promise for use in the endothermic fuels initiative presently underway at AFWAL. All of the SMSC studies were performed in packed tube reactors and were designed to permit comparison with data for conventional heterogeneous catalysts used under the same operational conditions. The majority of the studies involved the dehydrogenation of methylcyclohexane (MCH) to toluene. This reaction system was selected because of the existing data base generated by the extensive studies at Shell Development using conventional heterogeneous platinum catalysts usually on alumina supports. Two modifications were made to the original statement of work. The first involved a one man-month study of platinum, in both conventional and SMSC mode, as an heterogeneous catalyst for the coupled dehydrogenation - Retro-diels-Alder reaction of JP-10 (exo-octahydro-4, 7-methano- 1H-indene). The second involved as its primary endeavor the use of alkali metal hydroxide eutectics in SMSC for catalytic dehydrogenation of methylcyclohexane to toluene. GRA

**N89-17680#** Fraunhofer-Inst. fuer Treib- und Explosivstoffe, Pfinztal-Berghausen (Germany, F.R.).
**PROCESS FOR ASSESSING THE STABILITY OF HAN (HYDROXYL AMMONIUM NITRATE)-BASED LIQUID PROPELLANTS Interim Report No. 4, 9 Dec. 1987 - 9 Jun. 1988**
R. Hansen, E. Backof, and H. J. DeGreiff 9 Jun. 1988 44 p
(Contract DAJA45-86-C-0056)
(AD-A200681; R/D-5554-AN-01) Avail: NTIS HC A03/MF A01 CSCL 21I

In the Fourth Interim Report, the decomposition mechanisms in the components of liquid propellants (LPs) based on Hydroxyl Ammonium Nitrate (HAN) are discussed. Experimental studies were carried out regarding the influence of a wide range of metal ions on the catalytic decomposition of these components and the possibilities of stabilizing them. In glass ampoules, the effect of metal ions, hydrogen concentration and of chelating agent (complex-forming) additives on the storage life of LP 1846 were also studied. In pressure/time experiments, the influence of catalytically active metal ions on the decomposition process was determined up to a final pressure of 4 bar. Quantitative analysis of the propellant components and decomposition products was conducted following these experiments. GRA

**N89-17681#** Battelle Columbus Labs., OH.
**FUEL-ADDITIVE SYSTEM FOR TEST CELLS Final Report, 5 Aug. 1987 - 25 Feb. 1988**
Dale W. Folsom Aug. 1988 34 p
(Contract F08635-85-C-0122)
(AD-A200801; AFESC/ESL-TR-88-17) Avail: NTIS HC A03/MF A01 CSCL 21E

The purpose of this project was to provide the U.S. Air Force with design data and a prototype of a fuel-additive system capable of reducing plume opacity during testing of a jet engine in a test cell. Jet engines are tested in a test cell after servicing and before placement in an aircraft. Certain jet engines, J-57, J-79, and TF-33 in particular, generate soot which exits the test cell in a plume of greater than 20 percent opacity (Ringelmann number of 1 or greater). This opacity exceeds the opacity limit (20 percent) set by the Environmental Protection Agency (EPA). The U.S. Air Force has previously funded projects that found two jet fuel additives, ferrocene and cerium octoate, that reduce the plum opacity. The scope of this project included the design, construction, and testing of a prototype fuel-additive system. The following report describes the fuel-additive system requirements, design parameters, design, fabrication, and testing of the prototype system. The prototype fuel-additive system, properly built and operated, will provide the U.S. Air Force a means of testing jet engines in test cells while staying within EPA opacity limits. GRA

# 29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.
For biological materials see *55 Space Biology*.

**N89-17682*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**MICROGRAVITY COMBUSTION DIAGNOSTICS WORKSHOP**
Gilbert J. Santoro, ed., Paul S. Greenberg, ed., and Nancy D. Piltch, ed. 1988 47 p Workshop held in Cleveland, OH, 28-29 Jul. 1987
(NASA-CP-10017; E-4213; NAS 1.55:10017) Avail: NTIS HC A03/MF A01 CSCL 22A

Through the Microgravity Science and Applications Division (MSAD) of the Office of Space Science and Applications (OSSA) at NASA Headquarters, a program entitled, Advanced Technology Development (ATD) was promulgated with the objective of providing advanced technologies that will enable the development of future microgravity science and applications experimental flight hardware. Among the ATD projects one, Microgravity Combustion Diagnostics (MCD), has the objective of developing advanced diagnostic techniques and technologies to provide nonperturbing measurements of combustion characteristics and parameters that will enhance the scientific integrity and quality of microgravity combustion experiments. As part of the approach to this project, a workshop was held on July 28 and 29, 1987, at the NASA Lewis Research Center. A small group of laser combustion diagnosticians met with a group of microgravity combustion experimenters to discuss the science requirements, the state-of-the-art of laser diagnostic technology, and plan the direction for near-, intermediate-, and long-term programs. This publication describes the proceedings of that workshop. Author

**N89-17683#** Zentrum fuer Angewandte Raumfahrttechnologie und Mikronavigation, Bremen (Germany, F.R.).
**[INFORMATION ON THE CENTER OF APPLIED SPACE TECHNOLOGY AND MICROGRAVITY]**
**[INFORMATIONSSCHRIFT DES ZENTRUM FUER ANGEWANDTE RAUMFAHRTTECHNOLOGIE UND MIKROGRAVITATION]**
Jan. 1988 68 p In GERMAN Original contains color illustrations
(ETN-89-93512) Avail: NTIS HC A04/MF A01

A drop tower; combustion of fluid droplets; motion of fluids in capillary tubes by variation of the surface tension; simulation of perturbed free-molecular flow about three-dimensional bodies; MUSES-A Moon mission; TOPAS (Transport Operation of Microgravity Payloads Assembled on Scout); aerodynamic

characteristics of missiles; and biotechnologically revelant cell cultivation experiments in space are described. ESA

**N89-17684*#** Universities Space Research Association, Huntsville, AL.
**A PROPOSED NON-INTRUSIVE METHOD FOR FINDING COEFFICIENTS OF SLIP AND MOLECULAR REFLECTIVITY IN MICROGRAVITY Interim Report**
D. A. Noever and F. E. Rosenberger (Alabama Univ., Huntsville.) Jan. 1989 41 p
(Contract NAS8-37301)
(NASA-CR-183558; NAS 1.26:183558) Avail: NTIS HC A03/MF A01 CSCL 22A

A proposed experimental program to look at a series of vapor transport properties measured along solid and liquid surfaces is described. The research objectives proposed are: (1) with accuracy otherwise unobtainable on ground, to determine the coefficient of slip measured between gases and the surfaces of liquids and solids; (2) for the first time, to classify and tabulate dominant surface effects found for a variety of solids, particularly those crystalized by vapor transport; and (3) to extend understanding of settling rates predicted for cosmic dust and condensed vapor falling through planetary atmospheres. The method used to obtain these objectives, has aided, to an order of magnitude, understanding of various liquid-gas interfaces such as oil and water. But to date, no similar characterization has proved successful for solids or liquids of uncertain densities. Likewise, no data exist in either ground-based research or as part of a microgravity program that, when collected with the high accuracy expected in low gravity, could definitely settle outstanding questions in kinetic theory, molecular dynamics, and cosmic physics. Author

# 31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

**N89-17685#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.
**BEHAVIOUR AND ANALYSIS OF MECHANICALLY FASTENED JOINTS IN COMPOSITE STRUCTURES**
Mar. 1988 307 p In ENGLISH and FRENCH Meeting held in Madrid, Spain, 27-29 Apr. 1987 Original contains color illustrations
(AGARD-CP-427; ISBN-92-835-0431-3) Copyright Avail: NTIS HC A14/MF A01

The rapidly increasing use of composite structures in NATO aerospace has intensified interest in methods of strength, and life analysis. At the same time the introduction of new tough resins has increased the static strength of composite joints with implications for the corresponding strength in fatigue. A number of NATO nations have built up data bases and developed methods for strength and life analyses; in order to take advantage of these resources the Structures and Materials Panel held a Specialists' Meeting, in conjunction with the 64th Panel Meeting, at Madrid, Spain on 27th-29th April 1987, under the chairmanship of Professor Vittorio Giavotto, to provide a focus for methods of analysis and the identification of research needs. This volume contains the papers presented at this Specialists' Meeting. For individual titles, see N89-17686 through N89-17705.

**N89-17686#** National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.
**LITERATURE REVIEW ON THE DESIGN OF MECHANICALLY FASTENED COMPOSITE JOINTS** **c37**
C. Poon *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 28 p Previously announced as N87-12872 (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

This report presents a literature review of the state-of-the-art analytical and experimental methodologies adopted in the aerospace industry for the design of mechanically fastened joints in composite structures. Results and conclusions obtained from the published literature relating to the effects of critical parameters, which include composite material system, fastener configuration and joint geometry, on the mechanical behavior and failure modes of composite mechanically fastened joints are discussed. Further research required to improve the design of composite mechanically fastened joints is identified as a result of this review. Author

**N89-17687#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Helicopter and Airplane Div.
**COMPARISON OF EXPERIMENTAL RESULTS AND ANALYTICALLY PREDICTED DATA FOR DOUBLE SHEAR FASTENED JOINTS** **c39**
J. Bauer and E. Mennle *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 8 p (For primary document see N89-17685 10-31)
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Experimental tests were carried out to investigate the strength of open holes and pin loaded holes, as well as the combination of both. The material used was 914 C/T300. The tests delivered enough information to represent the basis for the development of an analytic prediction method. The prediction method is based on a linear analysis, which provides the stress field around a hole loaded with any type of loading. To make use of this information, in order to predict the strength, some empirical influence has to be taken into account to produce good correlation between experimental and theoretical data. The obtained accuracy is shown, as well as diagrams representing theoretically derived notch sensitivity and the double shear pin pearing strength. Author

**N89-17688#** Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.
**RECENT STUDIES ON BOLTED JOINTS IN COMPOSITE STRUCTURES** **c39**
V. B. Venkayya, R. L. Ramkumar (Northrop Corp., Hawthorne, CA.), V. A. Tischler, B. D. Snyder, and J. G. Burns *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 14 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

A brief review of recent Air Force programs in bolted joints in composite structures is given. The review includes analytical methods development and experimental verification. Analytical methods address both single fastener and multifastener joints. A number of joint design variables, such as, finite geometry, fastener arrangement, joint service environment, and a number of relevant parameters are addressed. The test programs include static and fatigue specimens. Single fastener and multifastener joint tests were conducted to correlate the analysis results. Full scale test specimens were used to verify the overall analysis strategy. A comprehensive design guide was developed for the design and analysis of bolted joints in composite structures. This design guide is supported by four computer programs. Author

**N89-17689#** Politecnico di Milano (Italy). Dipartimento di Ingegneria Aerospaziale.
**DAMAGE GROWTH IN COMPOSITE BOLTED JOINTS** **c39**
V. Giavotto, C. Caprile, and G. Sala *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 12 p (For primary document see N89-17685 10-31)
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Static and fatigue failures of composite joints are dominated by the growth and propagation of typical damages, up to some catastrophic condition. Starting from experimental observations some typical damage propagation patterns are identified and analyzed with simple models and finite element schemes. This extension of the fracture mechanics approach, to a broader class of damages allows some insight into the intricate behavior of joints, and gives some suggestion for interpreting and correlating experimental data. Author

**N89-17690#** Technische Hogeschool, Delft (Netherlands). Faculty of Aerospace Engineering.
**STRESSES IN PINLOADED ANISOTROPIC PLATES c39**
Th. deJong *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 17 p (For primary document see N89-17685 10-31)
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A method is presented for the calculation of stresses in an anisotropic plate with a row of equally spaced, pin-loaded holes. The pin-plate configuration represents a practical joint in a composite laminate where load is transferred from a row of mechanical fasteners into the laminate. The pins fit without clearance in the holes and they are supposed to be infinitely rigid. Numerical results are presented showing various effects of geometrical and material parameters on the stress distribution. The problem of a row of pin-loaded holes in an anisotropic plate is a complicated one of the mixed-boundary type. Several solutions can be found in literature based on simplifying assumptions regarding symmetry and geometry of the problem. The present solution is more general in those respects. It can be considered to be an application of Leknitskii's theory on stress distributions in anisotropic plates with holes. With this theory the determination of the stresses is reduced to the determination of two complex functions which must satisfy the specified boundary conditions of the problem. Author

**N89-17691#** Saab-Scania, Linkoping (Sweden).
**AN ANALYSIS METHOD FOR BOLTED JOINTS IN PRIMARY COMPOSITE AIRCRAFT STRUCTURE c05**
Ingvar Eriksson *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 19 p Prepared in cooperation with Royal Inst. of Tech., Stockholm (Sweden). (For primary document see N89-17685 10-31)
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The analysis of bolted joints in composite structure requires, like structural analysis in general, methods for determining the stress distributions and relevant failure criteria. The stress analysis procedure discussed here starts by addressing the joints as an integrated part of the overall structure. The stresses in the vicinity of the hole boundary are obtained through a series of finite element analyses, which starts with an overall load distribution analysis and ends with a two-dimensional detailed contact stress analysis of the most highly stressed region in the joint. Strength is predicted for two basic failure modes occurring in a joint, net-tension and bearing failure. The failure hypotheses for these failure modes are described. Both the stress analysis and failure hypotheses are performed and established, respectively under certain idealizations. The conditions in a real joint in an aircraft may differ from these idealizations. Hence, further work is required and is also proposed here. The analysis procedure described here is based on today's powerful computer facilities and offer great advantages compared with more empirical procedures. The procedure is presently used at Saab Aircraft Division. Author

**N89-17692#** Northrop Corp., Hawthorne, CA. Aircraft Div.
**STRENGTH ANALYSIS OF MECHANICALLY FASTENED COMPOSITE STRUCTURES c39**
R. L. Ramkumar, E. S. Saether, K. Appa, and V. B. Venkayya (Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.) *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 22 p (For primary document see N89-17685 10-31)
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An analysis is presented for the strength prediction of bolted composite structures, based on the average stress failure criterion. The analysis incorporates analytically derived special finite elements (loaded hole, unloaded hole, plain and effective fastener elements) into the Strength Analysis of Multifastener Composite Joints (SAMCJ) computer code. The loaded hole, unloaded hole and plain elements are derived from a doubly-connected laminate analysis that accounts for the effects of finite plate dimensions via a least squares boundary collocation solution procedure. The effective fastener element is derived from a fastener analysis that accounts for fastener shear and bending effects and through-the-thickness effects in the bolted laminates. The special finite elements in the SAMCJ code are developed using Argyris' natural mode method. The bolted plates are modeled using these elements, a conventional solution procedure yields the fastener loads and the stress state in each plate, and average stress failure criteria are used for strength prediction. The characteristic distances for net section, shear-out and bearing failures are assumed to be material constants obtained through limited testing. Author

**N89-17693#** Dornier-Werke G.m.b.H., Friedrichshafen (Germany, F.R.). Technology Programs.
**TYPICAL JOINTS IN A WING STRUCTURE c05**
Dieter Rose, Manfred Rother, and Helmut Schelling (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart, Germany, F.R. ) *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 14 p (For primary document see N89-17685 10-31)
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For the development of the Alpha-Jet carbon fiber reinforced plastic (CFRP) wing, typical connections between different components were examined both theoretically and experimentally. Environmental conditions - component humidity and temperature were considered mainly within the experimental work which was performed by the DFVLR-Stuttgart. Covered here are typical joints such as: (1) single-shear connection between skins and spars with low load transfer; (2) joints between skins and ribs due to interior tank pressure; and (3) multibolt joint between the CFRP skins and the fuselage attachment fittings with reference to bolt strength distribution and bearing stresses. Author

**N89-17694#** Service Techniques des Programmes Aeronautiques, Paris (France).
**IMPROVEMENT OF SPECIFIC FASTENING ELEMENTS FOR ASSEMBLING COMPOSITE STRUCTURES [MISE AU POINT D'ELEMENTS DE FIXATION SPECIFIQUES POUR ASSEMBLAGES DES STRUCTURES COMPOSITES] c39**
Raymond Louis *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 31 p In FRENCH (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

The development of composite material assemblages must take into account the inherent singularities of the materials used, for example, delamination, damage from impact and/or expansion, galvanic corrosion, etc. Several activities have been undertaken to improve specific fastening elements susceptable to the problems encountered with these structures. Specifically, these activities concern the development of a semi-tubular anti-peeling rivet of titanium T-40 for non-working structures; the development of interchangeable nuts that are used in association with an intermediary glass-fiber strip; and the modification of existing fasteners (structural screws and rivets). Author

**N89-17695#** Aeritalia S.p.A., Turin (Italy). Combat Aircraft Group.
**A STUDY TO OPTIMIZE THE CFRP-Al MECHANICAL JOINT IN ORDER TO REDUCE ELECTRICAL RESISTANCE c33**
F. Cipri and M. Pelosi *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 11 p (For primary document see N89-17685 10-31)
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The aim is to show what could be the kind of joints that would reduce the electrical resistance when a carbon fiber reinforced structure has to be jointed with an aluminum part. Assembly of specimens has been considered in fixed and removable configurations. The materials used to prepare the specimens to be jointed were carbon fiber reinforced plastic F263-T300 Fabric 3K70PW and Aluminum alloy 2024 - T3. Author

**N89-17696#** Royal Armament Research and Development Establishment, Christchurch (England).
**TEST SPECIMENS FOR BEARING AND BY-PASS STRESS INTERACTION IN CARBON FIBRE REINFORCED PLASTIC LAMINATES** **c24**
M. B. Snell and G. P. Burkitt *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 21 p Original document contains color illustratons (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

Compact test specimens for measuring the strength interaction behaviour of bolted joints subject to combined bearing and by-pass stresses have been studied. Multi-bolt specimens which have been successfully used to study these effects in aluminum alloy were found to be unsatisfactory because of the uncertainty in load transfer, and a new specimen based on parallel plates was developed. Bearing load at the holes is achieved through load transfer from the central carbon fiber reinforced plastic (CFRP) coupon to the parallel plates. The maximum ratio of bearing to bypass loads is limited by the initial fit of the bolt and by subsequent bolt/hole deformation under load. However the specimens recommended are capable of applying a wide range of bearing/bypass load ratios. Sample strength interaction envelopes were produced for a Hercules IM6 fiber and Ciba-Geigy Fibredux 6376 resin laminate of typical wing skin lay-up, 5.5 mm thick. Both tension and compression quadrants were studied, with two hole sizes, in both double shear and single shear. The interaction behavior was similar in both tension and compression for 6.35 mm holes in double shear, but in the case 0f 9.5 mm bolts there was less interaction in compression than in tension. Countersunk fasteners in tension appeared to suffer little reduction in net strength due to bearing stresses. Author

**N89-17697#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**BEARING-BYPASS LOADING ON BOLTED COMPOSITE JOINTS** **c39**
J. H. Crews, Jr. and R. A. Naik (PRC Kentron, Inc., Hampton, VA.) *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 13 p (For primary document see N89-17685 10-31)
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A combined experimental and analytical study has been conducted to investigate the effects of simultaneous bearing and bypass loading on a graphite/epoxy (T300/5208) laminate. Tests were conducted with a test machine that allows the bearing-bypass load ratio to be controlled while a single-fastener coupon is loaded to failure in either tension or compression. Test coupons consisted of 16-ply quasi-isotropic graphite/epoxy laminates with a centrally-located 6.35 mm bolt having a clearance fit. Onset-damage and ultimate strengths were determined for each test case. Next, a finite element stress analysis was conducted for each test case. The computed local stresses were used with appropriate failure criteria to analyze the observed failure modes and strengths. An unexpected interaction of the effect of the bypass and bearing loads was found for the onset of compression-reacted bearing damage. This interaction was caused by a decrease in the bolt-hole contact arc and a corresponding increase in the severity of the bearing loads. The amount of bolt-hole contact had a significant effect on local stresses and, thus, on the calculated damage-onset and ultimate strengths. An offset-compressible failure mode was identified for laminate failure under compression bearing-bypass loading. This failure mode appears to be unique to compression bearing-bypass loading and, therefore, cannot be predicted from simple tests. Author

**N89-17698#** Construcciones Aeronauticas S.A., Madrid (Spain).
**BOLTED JOINTS IN COMPOSITES PRIMARY STRUCTURES** **c39**
A. Rutz *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 8 p (For primary document see N89-17685 10-31)
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In the design of composite parts in primary structures, it is necessary to use bolted joints because of inspection requirements and the need for partial disassembly, repairability, access to the structure and for manufacturing breaks. The proven methodology for bolted joints in metallic structures cannot directly be applied to bolted joints in composites because of material anisotropy, susceptibility to the environment and, specially, due to the brittle behavior of typical carbon/epoxy joint members up to ultimate failure. In typical highly loaded multirow joints, a tension type failure generally occurs. Peak tangencial stresses at the edge of fastener hole produces fiber break-out. Stress concentration factors governs the failure, as in metal joints under fatigue loads. A methodology for composite bolted joint analysis must be able to size any particular joint design, avoiding the need for detail design tests. The approach under the present work correlates stress concentration factors in elastic-isotropic materials with those which appear in composites, by means of an empirically determined relief factor. CASA has developed a test plan which includes several hundreds of coupons. Basically, bearing strength allowables and stress concentration factors, are investigated. Author

**N89-17699#** Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
**THE STATIC STRENGTH OF BOLTED JOINTS IN FIBRE REINFORCED PLASTICS** **c24**
F. L. Matthews *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 9 p (For primary document see N89-17685 10-31)
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Joints in glass fiber reinforced plastics (GFRP) and Kevlar fiber reinforced plastics (KFRP) laminates show similar characteristics to those in carbon fiber reinforced plastics (CFRP) but with differences brought about by the low elastic modulus of glass fibers, and the low compressive strength of Kevlar fibers. Data is presented for GFRP laminates manufactured from layers of unidirectional fiber prepreg, and for KFRP laminates manufactured from layers of balanced, bi-directional, woven fabric prepreg. Comparative data for CFRP is also given. As far as GFRP is concerned, test on single-hole joints show that the effects of width, end distance, hole size, bolt clamping pressure and stacking sequence are similar to those in CFRP. In general, strength levels for GFRP are about 20 pct below those for CFRP. A stronger interaction between failure modes is found for GFRP, which also shows a greater tendency to delaminate rather than showing in-plane shear or tensile cracking. Due to the nature of the prepreg the range of possible lay-ups for KFRP is restricted. Bearing strengths are generally in the range 50 to 600 MN/sq m. Overall behavior is found to be similar to other FRP although the ultimate failure mode is almost invariably tensile. There is evidence that the inherent compressive characteristics of Kevlar fiber contribute to the low bearing strength. Surprisingly, although very large hole distortions are seen at failure, there is very little evidence of resin cracking. Author

**N89-17700#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Helicopter and Airplane Div.
**MECHANISM OF SINGLE SHEAR FASTENED JOINTS** **c39**
J. Bauer *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 6 p (For primary document see N89-17685 10-31)
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The problems arising with the strength of single shear fastened joints are considerably greater than those of double shear joints. The additional (or secondary) bending moment loads not only the cover plates, but also causes considerably bending in the fasteners. If one of the cover plates is of composite material its brittleness and relatively low bearing strength lead to new problems. Experimental data were produced with a 100 percent load transfer specimen using a carbon fiber reinforced plastic (CFRP) to metal joint. Taking the specimen configuration as a basis, the interaction of bolt bending and local load introduction into the two plates is shown in form of diagrams based on theoretical investigations. Author

**N89-17701#** Aeritalia S.p.A., Naples (Italy).
**JOINING OF CARBON FIBER COMPOSITE WITH FASTENERS** **c24**
Salvatore Pagliuso *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 5 p (For primary document see N89-17685 10-31)
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This paper deals with the Aeritalia experience on drilling techniques and fastener selection for advanced composite assembly. Details are provided on fabrication techniques. Information is given on corrosion prevention. Author

**N89-17702#** Avions Marcel Dassault, Saint-Cloud (France).
**BOLTED SCARF JOINTS IN CARBON COMPOSITE MATERIALS. COMPARISON BETWEEN ASSEMBLIES WITH AN INTERFERENCE FIT AND THOSE WITH PLAY [ENTURES BOULONNEES EN MATERIAUX COMPOSITE CARBONE COMPARAISON ENTRE MONTAGES A INTERFERENCE ET MONTAGE A JEU]** **c24**
Daniel Chaumette *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 10 p In FRENCH (For primary document see N89-17685 10-31)
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Experimental results on the behavior of carbon assemblies with mechanical fasteners mounted with and without interference are presented. Interference tests have been conducted for the cases of unstressed joints and scarf joints. In contrast to the predictions of elastic stress theory, interference fit is not found to have a significant influence on the static strength of test specimens, even after fatigue loading. The present results can be explained by the fracture mode of the drilled composite parts which leads to delamination. Author

**N89-17703#** Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt (Germany, F.R.).
**EFFECT OF ENVIRONMENT AND IMPROVEMENT MEASURES ON STATIC AND FATIGUE STRENGTH OF BOLTED CFRP-JOINTS** **c39**
J. J. Gerharz and H. Huth *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 16 p (For primary document see N89-17685 10-31)
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Effects of environment, preloading, bushings, local reinforcements and joint laminate tailoring on the efficiency of carbon fiber reinforced plastic (CFRP) joints are documented. Thereby, joint efficiency at static, residual and fatigue strength is considered. The laminate lay-up, the fastener system, fastener fit and clamping stresses were not changed. The material used was 914 C/T300 or Fiberite 976/T300. Critical hot/wet condition expected in service reduced joint efficiency but preloading on fatigue design load level with superimposed temperature cycle per flight did not. Installation of metal bushings into fastener holes, local reinforcement by adding layers to the hole section, and joint laminate tailoring through strip design were introduced to reveal their ability to improve composite joint efficiency. They proved to be successful depending on design constraints and required joint performance. Author

**N89-17704#** Politecnico di Milano (Italy). Dipartimento di Ingegneria Aerospaziale.
**STIFFNESS AND RESIDUAL STRENGTH VARIATIONS ON MECHANICAL JOINTS IN CFRP SPECIMENS IN CYCLING LOADING** **c39**
C. Caprile and G. Sala *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 24 p (For primary document see N89-17685 10-31)
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An experimental study of the fatigue behavior of jointed specimens made of carbon fiber reinforced plastic has been carried out. Four different configurations and four laminations have been taken into account, to point out the influence of by-pass load/transfer load ratio and stacking sequence on specimen fatigue behavior. Loading frequency has been maintained at 20 C.P.S. in tension-tension tests at room temperature with dry test conditions. Fatigue loads have consisted in an alternate component (20 pct of failure load) superimposed on a constant tensile force (60 pct of failure load). The influence of different sequences of constant amplitude load blocks were also investigated. Residual strength and stiffness versus number of load cycles have been compared for the same stacking sequence by varying specimen configuration, and for different stacking sequences and equal configuration. Elastic and tensile characteristics have been monitored on-line by means of load-cells, LVDT transducers and strain gauges. Damage growth was inspected by making use of nondestructive tests like X-rays radiography with opaque enhanced penetrant liquids and electronic microscope photography. The final results have consisted of a correlation between damage growth and residual strength and stiffness of jointed specimens. Author

**N89-17705#** National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.
**BEHAVIOUR OF MECHANICALLY FASTENED JOINTS IN ADVANCED COMPOSITES** **c24**
C. Poon and R. Gould *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 14 p (For primary document see N89-17685 10-31)
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Experimental results obtained to date from an on-going test program are presented. The purpose of this program is to evaluate the performance of mechanical fastener systems in Narmco IM6/5245C, a high strain/tough resin composite identified as a promising material system for new aircraft designs. Preliminary results obtained from tensile tests on open-hole specimens and double-lap joints were used to characterize the notch strength and the bearing strength as influenced by the effect of design parameters involving geometric ratios, hole size and fastener torque. A constant amplitude tension-compression ($R = -1$) fatigue test was performed on a double-lap composite joint to assess a simple and effective technique based on hysteresis measurements for monitoring progressive elongation by as much as 26 pct at the end of the fatigue test. This was explained by the observation that graphite particles formed during the fatigue test reduce the clearance between the hole and the pin. Single-shear composite/titanium joints were tested to evaluate three fastener systems designed specifically for composite applications. Four single-shear joints were tested to date to the ultimate tensile strength. Author

**N89-17706#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Electromagnetic Wave Propagation Panel.
**SCATTERING AND PROPAGATION IN RANDOM MEDIA**
Mar. 1988 538 p In ENGLISH and FRENCH Meeting held in Rome, Italy, 18-22 May 1987
(AGARD-CP-419; ISBN-92-835-0444-5) Copyright Avail: NTIS HC A23/MF A01

The topic of scattering and progagation in random media has implications for the design, development, and operation of most military systems that radiate energy as a means of accomplishing their functions. Primary emphasis is on scattering and transmission in the atmosphere; however, other related random medium effects are not excluded. Modern methods of characterizing random media, mathematical methods and their applicability, effects on electromagnetic waves and the interpretation of these effects to specific system applications are described. The region of the spectrum considered is essentially unlimited and ranges from very long waves to optics. The performance of existing surveillance communication and navigation systems as well as the design of future systems is influenced by the propagation of energy via random media. An understanding of the nature of the medium and its impact on system design and performance is For individual titles, see N89-17707 through N89-17752.

**N89-17707#** Fondazione Ugo Bordoni, Rome (Italy).
**COUPLED-MODE THEORY APPROACH TO DEPOLARIZATION ASSOCIATED WITH PROPAGATION IN TURBULENT MEDIA** **c74**

B. Crosignani and P. DiPorto *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 5 p Prepared in cooperation with Aquila Univ., Italy (For primary document see N89-17706 10-31)
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The problem of light depolarization in a turbulent atmosphere is revisited by means of the coupled-mode theory. This allows in particular the evaluation of the depolarization ratio for a plane wave and compares its expression with that obtained in the frame of two distinct approaches predicting different behaviors. Author

**N89-17708#** Washington Univ., Seattle. Dept. of Electrical Engineering.
**EXPERIMENT AND THEORY FOR BACKSCATTERING ENHANCEMENT AND IMAGING IN RANDOM MEDIA** **c74**

Akira Ishimaru and Yasuo Kuga *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 10 p Sponsored in part by Army Research Office, Washington, DC and NSF, Washington, DC (For primary document see N89-17706 10-31)
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When a wave is incident on a dense distribution of discrete scatterers, turbulent media, or rough surfaces, the backscattering is enhanced under certain conditions giving a sharp peak in the backward direction. It is shown experimentally and theoretically that the angular width of the peak is related to the transport coefficient and that the enhancement is caused by the constructive interference of two waves traveling through the same particles in opposite directions. This phenomenon is identified as the weak Anderson localization. The backscattering enhancement can occur from turbulence or rough surfaces which are caused by several mechanisms. A measure of the quality of the image transmission is expressed by the modulation transfer function (MTF). It is shown experimental and theoretical studies on MTF and speckle interferometry based on the fourth order and short-exposure MTF which can produce diffraction-limited images through random scatterers. Author

**N89-17709#** Polytechnic Univ., Farmingdale, NY. Dept. of Electrical Engineering.
**GEOMETRICAL THEORY OF DIFFRACTION FOR HIGH-FREQUENCY COHERENCE FUNCTIONS IN WEAKLY RANDOM MEDIUM WITH INHOMOGENEOUS BACKGROUND PROFILE** **c32**

R. Mazar and L. B. Felsen *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 16 p (For primary document see N89-17706 10-31)
(Contract F49620-85-C-0028)
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The localization of high-frequency wave propagation around ray trajectories, and the reflection and (or) diffraction of these local plane wave fields by boundaries, inhomogeneities, and (or) scattering centers was combined via the Geometrical Theory of Diffraction (GTD) into one of the most effective means of analyzing high-frequency wave phenomena in complex deterministic environments. These constructs are incorporated into a stochastic propagation and diffraction theory for statistical moments of the high-frequency field in a weakly fluctuating medium with inhomogeneous background profile. Canonical problems with deterministic GTD furnish the propagators and the local reflection, refraction, and diffraction coefficients that relate incoming and outgoing wavefields. The major analytical building blocks include propagators described in local coordinates centered on the GTD ray trajectories in the deterministic inhomogeneous background environment; multiscale expansions in these coordinates, to chart and solve for the propagation properties of statistical measures of the parabolically formulated ray fields; Kirchoff or physical optics (PO) approximations, generated by GTD incident fields, to establish initial conditions for fields reflected from extended smooth surfaces; and point scatterer solutions to establish GTD initial conditions for small scatterers and edges. Author

**N89-17710#** Colorado School of Mines, Golden. Center for Wave Phenomena.
**MULTIPLE SCATTERING FROM ROUGH SURFACES** **c32**

John A. DeSanto *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 10 p (For primary document see N89-17706 10-31)
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A review of multiple scattering theories is presented with specific application to scattering from rough surfaces. This includes the limitations, advantages, and range of validity of both traditional methods such as the Kirchoff and perturbation methods as well as a discussion of modern methods. The latter include the connected diagram method (integral equations), the smoothing method, the stochastic Fourier transform approach, and the spectral method. The former two methods have an analog in the theory of wave propagation in random media. The latter method is analogous to a method developed for scattering from periodic surfaces. The modern mathematical approach to these problems is stressed. In this approach the exact stochastic integral equations are used to develop equations on averages of the field quantities. The two most prominent equations are the Dyson equation on the first moment of the field, and the Bethe-Salpeter equation on the second moment. For homogeneous surface statistics, the former yields the coherent specular scattering, and the latter yields the incoherent scattering. Formally, both can be expressed exactly in the sense that all orders of multiple scattering are included, but, in order to be solved, must be approximated. The Dyson equation was solved in lowest order approximation and illustrates the necessity of using multiple scattering techniques to describe coherent scattering. The situation with the Bethe-Salpeter equation, however, is not nearly so well understood, and the difficulty of finding approximation techniques for this equation are discussed. Author

**N89-17711#** Rome Air Development Center, Hanscom AFB, MA. Electromagnetics Directorate.
**REGIONS OF VALIDITY FOR SOME ROUGH SURFACE SCATTERING MODELS** **c74**

Robert J. Papa and John F. Lennon *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 16 p (For primary document see N89-17706 10-31)
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The objective is to examine the regions of validity that apply to the use of various models for describing rough surface scattering. The first area to be examined is how a small slope condition allows an integral representation of the physical optics (PO) cross section to be formed that does not require the high frequency geometric optics (GO) restriction. Next, for forward scattering, the extension of the roughness dependence of the PO scattering cross section from the case of Gaussian surface and correlation to a range of surfaces with different height statistics and correlation functions. This dependence is then examined for the small perturbation method (SPM) regime as well. Finally, the forward scattering PO results are extended to the case where the azimuthal angle theta sub s is not equal to 0 degrees. Author

**N89-17712#** Royal Signals and Radar Establishment, Malvern (England).
**MARKOV RANDOM FIELDS: A STRATEGY FOR CLUTTER MODELLING** **c32**

Stephen P. Luttrell *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 8 p (For primary document see N89-17706 10-31)
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The need for models of image texture (or clutter) are briefly reviewed. The use of detailed physical models is prohibited by the difficulty of characterizing the scatterer distribution and the scattering process which cause the texture, and so phenomenological modeling is used. It is proposed that certain statistics of the image be measured, and that synthetic images which are consistent with these measurements be generated by a

Monte Carlo method - this allows the need for further statistics to be tested. The relationship of this scheme to the well-known maximum entropy method for constructing least commital probability distributions is pointed out. Furthermore it is shown how a Markov random field model is generated by this process. Finally, some methods are suggested for selecting useful statistics, which are demonstrated by analyzing a synthetic aperature radar image of a wood and a sonar image of the sea bed. Author

**N89-17713*#** Texas Univ., Arlington. Wave Scattering Research Center.

**A SCATTERING MODEL FOR FORESTED AREA** **c32**

M. A. Karam and A. K. Fung *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 9 p (For primary document see N89-17706 10-31)

(Grant NAG9-115)

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A forested area is modeled as a volume of randomly oriented and distributed disc-shaped, or needle-shaped leaves shading a distribution of branches modeled as randomly oriented finite-length, dielectric cylinders above an irregular soil surface. Since the radii of branches have a wide range of sizes, the model only requires the length of a branch to be large compared with its radius which may be any size relative to the incident wavelength. In addition, the model also assumes the thickness of a disc-shaped leaf or the radius of a needle-shaped leaf is much smaller than the electromagnetic wavelength. The scattering phase matrices for disc, needle, and cylinder are developed in terms of the scattering amplitudes of the corresponding fields which are computed by the forward scattering theorem. These quantities along with the Kirchoff scattering model for a randomly rough surface are used in the standard radiative transfer formulation to compute the backscattering coefficient. Numerical illustrations for the backscattering coefficient are given as a function of the shading factor, incidence angle, leaf orientation distribution, branch orientation distribution, and the number density of leaves. Also illustrated are the properties of the extinction coefficient as a function of leaf and branch orientation distributions. Comparisons are made with measured backscattering coefficients from forested areas reported in the literature. Author

**N89-17714#** Royal Signals and Radar Establishment, Malvern (England).

**COHERENT SCATTERING FROM RANDOM MEDIA** **c36**

C. J. Oliver *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 12 p (For primary document see N89-17706 10-31)

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The representation and simulation of clutter textures in coherent scattering is discussed in terms of a correlated noise model. Initially expressions for the detected intensity when coherent radiation is scattered from a surface with fluctuating cross-section are derived demonstrating how the effects of surface statistics and correlation properties interact with the imaging function. Secondly, a model for the cross-section fluctuations based on negative-binomial or gamma-distributed statistics is propesed. When coherent radiation is scattered by a surface with these properties the resulting intensity distribution can be shown to be K distributed. Having derived theoretical predictions for the correlated noise model with a variety of spectral forms a texture simulation technique is proposed based on linear filtering which duplicates the two-point correlation properties of the observed intensity. Finally, a comparison of original image data, simulated textures, and the theoretical model is made for a number of examples of differing textures of both natural and manmade clutter. Author

**N89-17715#** Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.

**THE ENHANCEMENT EFFECT OF THE BACKSCATTERED INTENSITY IN A RANDOM MEDIUM** **c32**

C. C. Yang and K. C. Yeh (Illinois Univ., Urbana.) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 11 p (For primary document see N89-17706 10-31)

(Grants NSF ATM-83-12175; NSF ECS-83-11345)

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A wave gradually loses its coherence while propagating in a random medium. This is because the wave experiences decorrelation along a propagation path that has uncorrelated irregularities. If, however, different parts of the propagation path have correlated irregularities, the decorrelation of the wave will not proceed as rapidly as otherwise. This effect is most prominently manifested in the case of backscattering where the return wave propagates through the same irregularities as the outgoing wave. The average backscattered intensity can be shown to be higher than that expected from a wave propagating over a path equal to the round trip distance but through uncorrelated irregularities. This phenomenon is known as the enhancement effect. This enhancement effect is clearly revealed when the receiver is moved ever closer to the transmitter. As the separation between the receiver and the transmitter is reduced, the average scattered intensity will increase and reaches a peak when the receiver is co-located with the transmitter. If the wave statistics are in the saturation regime, this maximum increase amounts to a doubling of the average intensity. The enhancement effect is examined under various conditions. There can be backscattering from random irregularities themselves or from a deterministic scatter. The difference between weak and strong scattering is distinguished. The effects produced by various power spectral functions from the random medium are also considered. Author

**N89-17716#** Nebraska Univ., Lincoln. Dept. of Electrical Engineering.

**MULTIPLE SCATTERING EFFECTS OF RANDOM DISTRIBUTIONS OF IRREGULARLY SHAPED PARTICLES ON INFRARED AND OPTICAL PROPAGATION** **c74**

Ezekiel Bahar and Mary Ann Fitzwater *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 15 p (For primary document see N89-17706 10-31)

(Contract DAAG29-82-K-0123; NSF ECS-85-15794)

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Scattering and depolarization by layers of randomly distributed particles of irregular shape and finite conductivity are determined for infrared and optical electromagnetic excitations. The irregularly shaped particles considered here are spheres with random rough surfaces. The spheres are characterized by their two dimensional surface height spectral density functions or autocorrelation functions. Circularly and linearly polarized excitations at normal incidence as well as vertically and horizontally polarized excitations at oblique incidence are considered. The co-polarized and cross-polarized incoherent diffuse specific intensities (modified Stokes parameters) are determined by solving the vector form of the equations of radiative transfer. To this end the full wave approach which accounts for diffuse scattering as well as specular scattering in a self-consistent manner is used to evaluate the extinction cross sections as well as the scattering (phase) matrix for the irregularly shaped particles. Both single-scatter and multiple-scatter incoherent specific intensities are evaluated for particles with smooth as well as rough surfaces. It is shown that the particle surface roughness can have a significant effect on the diffuse specific intensities. The phenomenon of enhanced backscatter is also examined. Author

**N89-17717#** Royal Signals and Radar Establishment, Malvern (England).

**HIERARCHICAL SCATTERING MODELS** **c32**

E. Jakeman *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 11 p (For primary document see N89-17706 10-31)

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The most familiar descriptor of multi-scale structure in continuous scattering media is the power law spectrum which characterizes hierarchical or fractal behavior. The mathematical and phenomenological implications of adopting such models in scattering calculations will be discussed with particular reference to the statistical properties of amplitude scintillation generated by

a phase changing screen or diffuser. A brief summer of results obtained when the phase itself is a Gaussian random fractal will be followed by a more detailed review of the case when the phase gradient is fractal. This last model is not only more realistic for fluid systems subject to diffusive or other smoothing effects, but is also amenable to mathematical and numerical analysis. The geometrical optics contribution to the scattered intensity pattern is particularly easy to calculate and a number of results for the statistics of ray density fluctuations will be presented. Author

**N89-17718#** Royal Signals and Radar Establishment, Malvern (England).
**GENERATION AND PROPERTIES OF SELF-SIMILAR STOCHASTIC PROCESSES WITH APPLICATION TO RAY PROPAGATION IN RANDOM MEDIA** **c74**
J. H. Jefferson and J. D. Anderson *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 19 p (For primary document see N89-17706 10-31)
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The importance of random media containing many length scales, and propagation of waves in such media is now widely recognized. Specific mathematical models to generate stochastic processes which have self-similar properties will be analyzed. Examples are presented graphically to illustrate similarities and differences between processes with various degrees of roughness and it is shown how they are related to fractional integration and fractal dimension. Such processes are non-Markovian, in general, and both causal and noncausal models are shown to be stochastically equivalent. Their use in modeling the scattering of waves from rough surfaces, particularly in the geometrical optics limit, will be discussed and the effects of inner and outer scales investigated. Finally, the generalization to two and three dimensions is considered together with application to ray propagation in extended random media. Author

**N89-17719#** Illinois Univ., Urbana-Champaign.
**SPACE-TIME STATISTICS OF WAVES PROPAGATING THROUGH A DEEP PHASE SCREEN** **c32**
S. J. Franke and C. H. Liu *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 16 p (For primary document see N89-17706 10-31)
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Wave propagation through a deep phase screen is studied in which the properties vary randomly both with time and space. Two approaches will be discussed. One is analytical, the other involves numerical simulation. In the analytical approach, asympotic expressions for the space-time correlation functions of the wave field are derived for the case of Gaussian random irregularities. For the simulation approach, general prescribed space-time random variations of irregularities are generated and used to represent a time varying phase screen. This technique can be used to model a screen with a power law type of irregularity spectrum. Numerical propagation code is then used to compute the wave fields at the reception plane from which statistics will be calculated. The relations between the statistics of the wave fields and the space-time variations of the medium will be discussed. Applications of the results will be discussed. Author

**N89-17720#** National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
**LINE-OF-SIGHT MILLIMETER WAVE PROPAGATION CHARACTERISTICS** **c32**
S. F. Clifford, R. J. Hill, R. B. Fritz, R. A. Bohlander, and R. W. McMillan (Georgia Inst. of Tech., Atlanta.) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 7 p (For primary document see N89-17706 10-31)
(Contract MIPR-122-85)
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From 1983 to 1985 a team of scientists from NOAA's Wave Propagation Laboratory and Georgia Institute of Technology conducted an extensive set of millimeter wave propagation measurements. In five, thirty-day sessions, chosen for the widest variety of weather conditions, millimeter wave frequencies from 116 to 230 GHs were propagated over a 1.4 km horizontal path in Flatville, Illinois. Simultaneous, extensive measurements of the meteorology allowed a detailed comparison of the propagation characteristics with the current state of the atmosphere. The observations of millimeter wave propagation characteristics during clear air and sever weather are reported. Amplitude and phase spectra for propagation in clear air are compared with theory derived using the weak refractive turbulence approximation. Excellant agreement is found. Further, probability density functions appear to be; respectively, lognormal (amplitude) and Gaussian (phase difference), as expected from application of the central limit theorem. Interesting meteorological observations and their millimeter wave signatures will also be presented. Author

**N89-17721#** Office National d'Etudes et de Recherches Aeronautiques, Paris (France).
**OPTICAL IMAGERY ACROSS ATMOSPHERIC TURBULENCE [IMAGERIE OPTIQUE A TRAVERS LA TURBULENCE ATMOSPHERIQUE]** **c74**
G. Rousset, J. C. Fontanella, J. Primot, and A. Seve *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 13 p In FRENCH Previously announced in IAA as A87-46754 (For primary document see N89-17706 10-31)
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Three techniques for obtaining images with a resolution at the diffraction limit are compared to study the effects of atmospheric turbulence on the formation of optical images. The simplest method, the Knox and Thompson (1974) algorithm (based on a speckle interferometry method), requires the statistical properties of the turbulence to be stable, and involves the treatment of a large number of images. The deconvolution method, based on a wave front analysis, and the adaptive optic method, the most promising of the three candidates, require the presence of a highly luminescent source in the isoplanetary field in order to analyze the wave front. B.G.

**N89-17722#** British Aerospace Public Ltd. Co., Bristol (England). Naval and Electronic Systems Div.
**INFRARED ATMOSPHERIC TRANSMISSION/EMISSION MEASUREMENT IN A MARITIME ENVIRONMENT** **c74**
G. J. Bishop and I. W. Larkin *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 12 p Sponsored by Ministry of Defence, United Kingdom (For primary document see N89-17706 10-31)
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In 1985 a program of collaborative electro-optical research was agreed between the Admiralty Research Establishment (ARE) and British Aerospace, co-ordinated by the Naval and Electronic Systems Division at Bristol. The object of this research was to gather trials data on the performance of electro-optical systems in a maritime environment. In order to achieve this objective, it was important to measure the atmospheric transmission/emission close to the sea surface in a variety of weather conditions. During the course of the trail considerable experience was gained in the operation of various imaging sensors, especially in calibration and measurement techniques. The need to obtain calibrated measurements of atmospheric transmission/emission between the electro-optic sensor and any trial target is to be emphasized. How these measurements were made is described and the results compared to those predicted by the Lowtran 5 atmospheric model. How ozone absorption will affect the design of a passive surveillance system working in the ultraviolet band is also described. Author

**N89-17723#** Forschungsinstitut der Deutschen Bundespost, Darmstadt (Germany, F.R.).
**A PRECIPITATION SCATTER EXPERIMENT AT 30 GHz** **c32**
Heinz Schmiedel and Alfred Ochs *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 8 p (For primary document see N89-17706 10-31)
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An experiment was initiated to study scattering of microwaves at 30 GHz from precipitation, which is of importance in interference

analysis and system coordination. The measurements are made in a bistatic configuration with transmit and receive sites separated by some 25 km. The propagation paths are run in a vertical plane containing the two terminal sites. Four transmitters are operated at different fixed elevations, one receiver is connected to a fixed antenna, a second one to a steerable antenna. Thus a total of eight main-beam intersections are formed, from which precipitation scatter can be received under different scatter angles and at different heights up to 10 km. Both, horizontally and vertically polarized signals are measured. In addition, a line-of-sight link and a rain-scatter link are operated at 30 and 11 GHz for the purpose of comparison. To study precipitation scattering in a situation close to those of actual communication links, a further 100 km path is run at 30 GHz. The main objectives of the experiment are: studies of direct relevance to system design and coordination (long term statistics of transmission loss in various interference configurations, significance of backscatter in relation to forward scatter, influence of the melting layer, scattering from ice crystals up to a height of 10 km, and power density spectra and fading rate of the scattered signal); and studies of physical processes relevant to the precipitation scatter. The experimental set-up is described and first results of the measurements will be given. Author

**N89-17724#** National Telecommunications and Information Administration, Boulder, CO.
**OBSERVED PHASE DELAY THROUGH RAIN AT 96 GHz c32**
Kenneth C. Allen *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 11 p (For primary document see N89-17706 10-31)
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Observations of phase delay through rain at 96 GHz are presented. The results are pertinent for target identification when relative amplitude and phase information are used from circularly polarized radar returns. At the transmitter site, a 9.6 GHz source was vertically polarized and a 9.1 Ghz source was righthand circularly polarized. A single local oscillator phased locked both sources. At the receiver site, 1050 m away, the local oscillator was phase locked to the received 9.6 GHz signal. Both left- and right-hand circular polarizations at 96.1 were received using separate antennas. The phase of each polarization at 96.1 GHz was measured relative to the 9.6 GHz reference. This allowed the examination of the behavior of the differential phase delay of the circular polarizations. Author

**N89-17725#** Technische Hogeschool, Delft (Netherlands). Faculty of Electrical Engineering.
**FM-CW RADAR REMOTE SENSING OF HYDROMETEORS c32**
L. P. Ligthart and J. S. vanSinttruyen *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 15 p (For primary document see N89-17706 10-31)
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In order to investigate phenomena influencing co-polar attenuation and cross-polar discrimination along earth-space satellite paths and terrestrial radio links at frequencies above 10 GHz, the number density, geometry, and orientation of hydrometeors (rain, snow, hail, melting particles) along the path have to be characterized. The modeling of the melting process, the dielectric properties of melting particles, and fall velocity behavior of hydrometeors for Doppler velocity computation with vertically pointing radars are described. Attention is paid to backward scattering of ellipsoidal hydrometeors for radar polarimetry computations at arbitrary elevation angles, and to forward scattering of spherical hydrometeors for attenuation computations at high frequencies. The multi-parameter FM-CW radar system is able to measure the polarization properties and Doppler velocity spectra of hydrometeors with high resolution in range and reflectivity level. Preliminary results obtained with this radar system are shown, indicating the capabilities of combined Doppler- and polarimetry measurements for classification of hydrometeors along a satellite path. Author

**N89-17726#** Thomson-CSF, Velizy (France). Centre d'Applications Radars.
**MODELING OF ELECTROMAGNETIC WAVE AND SEA SURFACE INTERACTION [MODELISATION DE L'INTERACTION ENTRE UNE ONDE ELECTROMAGNETIQUE ET LA SURFACE DE LA MER] c32**
Michel Fournier *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 14 p In FRENCH (For primary document see N89-17706 10-31)
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The EM systems parameters and signal characteristics used in connection with ocean surface effects are reviewed. Hydrodynamic and statistical properties of the sea surface, including various spectral representations are covered. Finally, available models of EM wave and ocean surface interactions are also reviewed. These models consist of perturbation theory for EM waves which are large with respect to ocean waves, physical optics techniques for small EM wavelengths and a combination of both when EM and ocean wavelengths are of the same order. Author

**N89-17727#** Memorial Univ. of Newfoundland, St. Johns. Faculty of Engineering and Applied Science.
**ROUGH SURFACE PROPAGATION AND SCATTER WITH APPLICATIONS TO GROUND WAVE REMOTE SENSING IN AN OCEAN ENVIRONMENT c32**
John Walsh and Satish K. Srivastava *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 15 p Sponsored by Canadian Dept. of National Defence and Natural Sciences and Engineering Research Council of Canada (For primary document see N89-17706 10-31)
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Some properties of the vector integral equation representing a general formulation for propagation and scattering from rough surfaces are discussed. It is shown that under certain conditions the equation may be reduced to a Volterra equation of the second kind in the normal component of the surface field for an initially unexcited surface, and hence some confidence may be had in a Neumann series or successive approximation. Using the formulation, the backscattered field solutions at ground wave frequencies and resulting radar cross section solutions derived previously for a model of the ocean surface are presented and discussed. The source assumed is a vertical pulsed dipole. The choice of receiving antenna is left arbitrary. The second-order cross section contains terms in addition to those provided by existing theories. The additional terms may become very significant in certain Doppler frequency regions and hence required for ocean clutter estimation in the detection of certain types of surface targets. Some of the predictions were verified experimentally. Author

**N89-17728#** Thessaloniki Univ. (Greece). Dept. of Electrical Engineering.
**WAVE-TILT SOUNDING OF TROPOSPHERIC DUCTS ABOVE THE SEA c32**
D. P. Chrissoulidis and E. E. Kriezis *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 12 p (For primary document see N89-17706 10-31)
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The possibility to detect tropospheric ducts above the sea through airborne wave-tilt measurements is investigated. Sea roughness and tropospheric refractivity anomalies associated with the presence of ducts are incorporated in an iterative procedure resulting in wave-tilt versus frequency diagrams at some altitude above sea level. In general, the diagram correponding to ducting conditions appears sifted by delta f with respect to the diagram of the standard troposphere. This frequency shift is rather insensitive to variations of sea state, duct thickness, and optimum coupling height. It is though strongly dependent on duct intensity, delta M. The diagram of delta f vs. delta M is not far from linear in the VHF band and thus offering itself for delta M through delta f measurements. Author

**N89-17729#** Royal Signals and Radar Establishment, Malvern (England).
**I-BAND MULTIPATH PROPAGATION OVER THE SEA SURFACE** **c32**
C. J. Baker and K. D. Ward *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 5 p (For primary document see N89-17706 10-31)
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A series of measurements are summarized which were aimed at studying the phenomenon of multipath resulting from line of sight, two way, microwave propagation over the sea surface. It was observed that the expected lobing structure, due to the interference of the direct and reflected signals is destroyed when the sea surface becomes sufficiently rough, suggesting the coherent part of the forward scattered sea reflection to be zero. Further, it was observed that although the pulse by pulse fluctuations show deep fading characteristics they may be modeled by the Rice-squared distribution. However, it was found that care must be taken in choosing the duration of the measurement when evaluating the statistical properties of the data. Author

**N89-17730#** Rennes Univ. (France). Dept. Antennes.
**MEASUREMENT AND MODELING OF 36 GHz SEA REFLECTION PHENOMENA [ETUDE EXPERIMENTALE ET MODELISATION DU PHENOMENE DE REFLEXION SUR LA MER A 36 GHZ]** **c32**
Yvonick Hurtaud, Claude Terret, Jean-Pierre Daniel, and Alain Junchat (Centre d'Electronique de l'Armement, Bruz, France ) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 14 p In FRENCH (For primary document see N89-17706 10-31)
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During the 1984 autumn, a measurement campaign of the propagation of electromagnetic waves at 36 GHz was conducted on the French Atlantic coast, near Lorient. The length of the link between the transmitting site, located on the isle of Groix and the receiving site at Gavres, was 9.7 km. Owing to the small height of the antennas, a part of the emitted energy was reflected by the sea surface. At the reception point, the fields coherent interference produced by the direct and reflected radiations, gave a signal varying periodically with the influence of the tides. In order to study the specular reflection phenomena over the sea, specific measurements were made with the help of an elevator. It allowed the height of the receiving antenna to change on a distance of about 5 meters, maintaining that way, at the same time, steady environmental conditions. Thanks to this device, the forward specular reflection coefficient, at a frequency of 36 GHz could then be determined. The measurements which were made, proved the good agreement between then and the theory, especially in the case of strong roughness. Following these results, a model of propagation based on specular reflection was developed to be compared with the measurements. In some particular meteorological situations, a distortion of the interference figures can be observed, due to variations of the atmospheric structure.
Author

**N89-17731#** Naval Research Lab., Washington, DC. Ionospheric Effects Branch.
**RANDOM PROPAGATION THROUGH THE LONGWAVE CHANNEL** **c32**
F. J. Kelly, F. J. Rhoads, and M. D. Andrews (Interferometrics, Inc., Vienna, VA.) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 27 p (For primary document see N89-17706 10-31)
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The longwave propagation channel in the earth-ionosphere waveguide has many characteristics of a random medium. The lower surface of the waveguide is sometimes rough or smooth depending on the propagation path considered. The ionospheric boundary is significantly perturbed by sudden events during both daytime and nighttime. The polar-arctic regions of the world evidence these effects in a striking manner and require different statistical treatment. Recent observation of longwave fields in the arctic will be described and their degree of agreement with statistical predictions displayed. Author

**N89-17732#** National Telecommunications and Information Administration, Boulder, CO. Inst. for Telecommunication Sciences.
**MODELING OF WIDEBAND HF CHANNELS** **c32**
Martin Nesenbergs *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 16 p (For primary document see N89-17706 10-31)
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Laboratory simulation of wideband high frequency (HF) system performance is currently not possible because such simulators do not exist. Moreover, there are no validated HF channel models for bandwidths of the order of one megahertz, on which to base the simulator design. Additive distortions, namely noise and interference, in the HF band are briefly reviewed. An introduction and an appraisal of past narrowband HF models are presented: their background, validation tests, and the NTIA/ITS development of the Watterson's simulator. That laboratory tool, judged best by many, works in real time and offers accurate representations of HF channel bandwidth up to 10 or 12 kHz. In the present study an extension to wideband models is attempted. Unfortunately, it suffers from an apparently serious shortage of measured data for the time-varying channel transfer function. A possible wideband model is hypothesized, conjectures are made, many questions are raised, but hardly any are answered. One is left faced with a requirement for an experimental program that is to ascertain the wideband characteristics of multipath fading for digital radio transmission in the HF band and over propagation paths of interest. Author

**N89-17733#** National Telecommunications and Information Administration, Boulder, CO. Inst. for Telecommunication Sciences.
**PROPAGATION AND PERFORMANCE MEASUREMENTS OVER A DIGITAL TROPOSCATTER COMMUNICATIONS LINK** **c32**
John J. Lemmon *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 13 p Sponsored by Department of the Army, Washington, DC (For primary document see N89-17706 10-31)
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Propagation and performance measurements that were obtained over a digital troposcatter communications link betwee Bockberg, West Germany, and West Berlin are discussed. The measurements were unusual in that three general types of data were collected simultaneously over the link: propagation data, digital performance data, and meteorological data. The propagation data include received signal level (RSL) and multipath measurements made with a channel probe, the performance data consist of bit-error data obtained from a 1.544 Mbps T1 bank, and the meteorological data (in the form of radiosonde messages) were used to generate profiles of the radio refractive index over the link. The basic principles and instrumentation of the channel probe and the test configurations used to obtain these data are discussed. Then the results of analyses of these data are presented and discussed. These results include the measured impulse response of the channel, delay spread, RSL, bit-error ratios, and refractive index profiles. Potential relationships among these results are investigated in order to assess the impact of various troposcatter channel conditions on digital radio performance. In particular, both the definition and methods of utilizing the all important parameter of delay spread. These considerations range from the simple parameter of 2 sigma values to a more complete evaluation of the dynamic properties of delay-spread derived from the channel probe data. Previous studies have addressed many facets of troposcatter propagation. An attempt was made to bring all of these facets together, to present a more complete description of the troposcatter channel, and to enhance future digital upgrades of existing troposcatter links. Author

**N89-17734#** National Telecommunications and Information Administration, Boulder, CO. Inst. for Telecommunication Sciences.

**MEASUREMENT, MODELING AND SIMULATION OF LOS MICROWAVE CHANNELS** **c32**

James A. Hoffmeyer and Lewis E. Vogler *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 16 p (For primary document see N89-17706 10-31)

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A brief summary of prior work in the field of microwave line-of-sight (LOS) channel propagation measurements, channel models, and channel simulators is presented. The objective of these efforts is the reliable prediction of microwave radio performance on any specified link. The ideal channel simulator is one that operates at RF, operates under computer control, is dynamic, stimulates both minimum and nonminimum phase distortions, and has a dual channel capability for the comparative evaluation of space and frequency diversity radios. Significant parameters of this ideal simulator should be based on a model that was validated through propagation measurements on different representative paths. Although much progress was made, a number of issues remain. The work in the area of channel simulation, propagation measurements, and modeling is described. Together with channel measurement programs currently underway, this work should be helpful in the resolution of many of the remaining issues. Author

**N89-17735#** Emmanuel Coll., Boston, MA.

**STRUCTURES OF DENSITY AND VELOCITY FLUCTUATIONS IN THE AURORAL OVAL AND THEIR IMPACT ON COMMUNICATION AND RADAR SYSTEMS** **c32**

Sunanda Basu, Santimay Basu, W. R. Coley, and N. C. Maynard (Air Force Geophysics Lab., Hanscom AFB, MA.) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 14 p (For primary document see N89-17706 10-31)

(Contract F19628-86-K-0038)

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A class of ionospheric irregularities in the auroral oval associated with large structured plasma flows was recently isolated with radar and satellite in-situ measurements. These density irregularities have large power spectral densities (PSD) at short scale lengths. The density and velocity spectra in such regions are characterized and their impact on scintillation observations and radar performance are discussed. The structures plasma flows may occur in association with large or small field aligned currents. The velocity spectra have fairly shallow power spectral indices in regions of large field aligned currents and are steep in regions of small current flows. The density spectra, on the other hand, can be described by a power law index of approximately -2 in both the large and small field aligned current regions. The temporal structure of scintillations will thus be dictated not only by the scattering strength but also by the large flow velocities encountered in the auroral oval. The density structures with large PSD at short scale lengths are expected to introduce considerable ionospheric clutter in HF radar systems. The effect of E-region conductivity in modifying small-scale F-region structure and its implication for communication and radar systems is discussed. Author

**N89-17736#** Telettra S.p.A., Chieti (Italy).

**IMPULSE RESPONSE MEASUREMENTS AND CHARACTERIZATION OF WIDEBAND VHF RADIO LINES** **c32**

P. LoMuzio, G. Guidotti, N. Benvenuto, and S. Pupolin (Padua Univ., Italy ) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 14 p (For primary document see N89-17706 10-31)

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Results of an experiment to determine the characteristics of VHF radio links are presented. The experiment was conducted in a plain surrounded by mountainous area with a system that allowed the measurement of the delay spread (difference between the maximum and minimum delay propagation paths) due to multipath propagation. Various sites were explored with measurements being made at different carrier frequencies within the VHF band. In this experiment, an interesting result was that delay spreads increase with the carrier frequency. Author

**N89-17737#** Cambridge Univ. (England). Ocean Acoustics Group.

**INTENSITY FLUCTUATIONS DUE TO MOVING POINT SOURCES** **c71**

B. J. Uscinski *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 7 p (For primary document see N89-17706 10-31)

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An understanding of point sources in random media is essential if dealing with real sources, and effects such as source motion. Reliable theory now exists for the intensity fluctuations due to point sources in such media. Numerical simulations of such fluctuations agree with theoretical results. The intensity fluctuation theory and simulations were extended to deal with the case of a moving source and observer. It is shown that as regards ensemble averaged quantities such as the intensity fluctuation spectra there is reciprocity between motion of the source and that of the observer. However, such reciprocity does not exist if one is dealing with the detailed fluctuation pattern arising in a particular realization of a random medium. Author

**N89-17738#** Cambridge Univ. (England). Ocean Acoustics Group.

**CROSS-FREQUENCY CORRELATION OF INTENSITY FLUCTUATIONS IN THE PHASE-CHANGING MEDIA** **c32**

Sarah J. Miller *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 4 p (For primary document see N89-17706 10-31)

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The cross-correlation of intensity fluctuations at two different wave frequencies is a useful tool in remote sensing of sources and random phase changing media. The cross-spectrum of these fluctuations is investigated here for the model of a deeply modulated phase changing screen. An analytic expression is obtained for this spectrum and the effect of increasing frequency differences is demonstrated. Finally, the statistics of the wave fields in the far field are examined by comparing the second and fourth moments. It is shown that the relationships of these moments is consistent with the assumption that the statistics of a monochromatic field are normal in the far field, but inconsistent with wave fields of different frequencies having a joint normal distribution there. Author

**N89-17739#** Laboratoire Central de Telecommunications, Paris (France).

**MODELING ELECTROMAGNETIC WAVE PROPAGATION THROUGH A STRONGLY-FLUCTUATING IONIZED MEDIUM BY THE PHASE SCREEN METHOD [MODELE DE PROPAGATION D'UNE ONDE ELECTROMAGNETIQUE DANS UN MILIEU IONISE A FORTES FLUCTUATIONS PAR LA METHODE DES ECRANS DE PHASE]** **c32**

Y. Beniguel and B. Gibert (Aerospatiale Etablissement des Mureaux, France ) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 11 p In FRENCH (For primary document see N89-17706 10-31)

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An irregular medium, such as the high altitude ionosphere, is defined statistically using the mean value and variance of electron density and the spectral density of propagation index fluctuations. This data permits the characterization of the signal phase as a random variable in the medium propagation. The spatial distribution of the irregularities, connected with the action of the terrestrial magnetic field, produces a very anisotropic medium. The propagation calculation is difficult to carry out if one simply specifies a variation profile of the mean electron density. The method described and used in this paper consists of the discretization of the medium in successive phase screens of low density. The method of resolution is explained. The results presented support signal amplitude, phase and scintillation rate calculations. Author

**N89-17740#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Electrical Engineering.
**ON THE APPLICABILITY OF CONTINUOUS SCATTERING METHODS TO DISCRETE SCATTERING PROBLEMS** **c71**
Ioannis M. Besieris *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 6 p (For primary document see N89-17706 10-31)
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The equivalence between continuous and discrete scattering modeling was examined at two statistical levels: the direct interaction/ladder approximation (continuous) - Twersky approach (discrete); and the first order smoothing approximation (continuous, discrete). Full first and second order moment equivalence was established only at the level of the first order smoothing (or bilocal) approximation and, even then, for soft scatterers with weak transition operators. Author

**N89-17741#** Wayne State Univ., Detroit, MI. Dept. of Mathematics.
**ON FUNCTIONAL APPROACH TO RANDOM WAVE PROPAGATION PROBLEMS** **c64**
P. L. Chow *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 6 p Sponsored by NSF, Washington, DC (For primary document see N89-17706 10-31)
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The method of functional integration for wave propagation through random media is presented. The method is applied to calculate the coherent and mutual coherent functions for a parabolic wave. It is shown that a correction to the parabolic Markovian approximation can be easily made in this setting. Then the method is also applied to the random Helmholtz equation. It is possible to solve this problem by either Feynman's path integral or Wiener's integral. Asymptotic evaluation of such functional integrals is described. Examples and general remarks are provided. Author

**N89-17742#** Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
**NUMERICAL SIMULATION OF WAVE PROPAGATION IN RANDOM MEDIA** **c64**
Mark Spivack *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 5 p (For primary document see N89-17706 10-31)
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Numerical simulation of random wave propagation has numerous applications. It enables the examination of individual features of the wave-field and the modeling of actual experiments. Statistical quantities such as average power spectra of intensity fluctuations can also be obtained for comparison with theory. Some of the techniques and uses of numerical simulation are explained and some of the results which emerge are described. Author

**N89-17743#** Messina Univ. (Italy). Istituto di Struttura della Materia.
**SELECTIVE EXTINCTION OF A DISPERSION OF SINGLE AND AGGREGATED LAYERED SPHERES** **c32**
F. Borghese, P. Denti, R. Saija, O. I. Sindoni (Chemical Research and Development Center, Aberdeen Proving Ground, MD.), and G. Toscano *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 4 p (For primary document see N89-17706 10-31)
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The extinction coefficient for a low-density dispersion of small stratified spheres as well as for that of their binary aggregates was calculated. The results are discussed for 50 A spheres with a core of MgO and a coating of Al, a case in which a dramatic shift of the resonance peaks as a function of the thickness of the coating occurs. This suggests that a suitable choice of the thickness could produce selective extinction in a wide range of frequency, although this effect could be strongly weakened if a considerable percentage of spheres aggregate. Author

**N89-17744#** Societe Mothesim, Le Plessis-Robinson (France).
**ELECTROMAGNETIC REFLECTIVITY IN NON-HOMOGENEOUS CONTINUOUS RANDOM MEDIA WITH CYLINDRICAL SYMMETRY [REFLECTIVITE ELECTROMAGNETIQUE D'UN MILIEU ALEATOIRE INHOMOGENE CONTINU A SYMETRIE CYLINDRIQUE]** **c32**
G. Muller and F. Molinet *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 12 p In FRENCH (For primary document see N89-17706 10-31)
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For the calculation of electromagnetic reflectivity in random media, it is common to separate the mean reflectivity of the medium from its fluctuations. However, studies have shown evidence of marked interaction between the two. A calculation scheme is presented which takes into consideration the interaction between the medium mean reflectivity and fluctuations. The medium discussed is an ionized plasma with fluid flow. Cylindrical coordinates are used for field calculations. Results for global and local phenomena and turbulence are discussed. Author

**N89-17745#** Pennsylvania State Univ., University Park. Center for the Engineering of Electronic and Acoustic Materials.
**MULTIPLE SCATTERING OF WAVES IN RANDOM MEDIA CONTAINING NON-SPHERICAL SCATTERERS** **c64**
Vasundara V. Varadan, Vijay K. Varadan, and Yushieh Ma *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 8 p (For primary document see N89-17706 10-31)
(Contracts DAAG29-84-K-0187; DAAG29-85-K-0234)
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The effect of multiple scattering, scatterer geometry, statistics of the positional and orientational distribution functions on the propagation of time harmonic electromagnetic waves in a medium containing a random distribution of nonspherical scatterers are considered. Some of the features that complicate the analysis are: the size of the scatterers is comparable to the wavelength of the propagating wave; the volume fraction occupied by the scatterers need not necessarily be small; and the impedance mismatch between the scatterers and the host medium need not necessarily be small. These in turn necessitate some of the effects to be examined, namely: detailed modeling of scatterer geometry and scatterer response, multiple scattering effects, and the effects of correlations. Some recent results using nonspherical statistics for the second moment of the field are presented. The pair correlation function for spheroidal particles was generated by Monte Carlo simulation as a function of the distance between then and the direction of the vector joining their centers. At present the pair correlation function is being generated for randomly oriented spheroids and the effects of interparticle forces are considered as well as high order correlation functions for clusters of particles. All of these were incorporated into the multiple scattering calculations and compared with available experimental results. Author

**N89-17746#** New Mexico State Univ., Las Cruces. Dept. of Physics.
**NON-LINEAR EFFECTS ON THE ATMOSPHERIC TRANSMISSION OF HIGH-FLUX ELECTROMAGNETIC BEAMS** **c32**
R. L. Armstrong *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 3 p (For primary document see N89-17706 10-31)
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The propagation of an intense beam of electromagnetic radiation through the atmosphere is accompanied by a host of interactions between the beam and atmospheric constituents present along the propagation path. These interactions may have significant influence on the characteristics of the propagating beam. Aerosol-beam interactions are discussed which, in many cases of practical interest, are the dominant interactions between the atmosphere and the propagating beam. Theoretical experimental insights are reviewed in a survey of this complex problem. Author

**N89-17747#** Rome Air Development Center, Hanscom AFB, MA. Applied Electromagnetics Div.

**A STATISTICAL ANALYSIS OF POLAR METEOR SCATTER PROPAGATION IN THE 45 TO 104 MHz BAND** **c32**

M. J. Sowa, J. M. Quinn, J. E. Rasmussen, P. A. Kossey, and J. C. Ostergaard (Danish Research Center for Applied Electronics, Hoersholm.) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 9 p (For primary document see N89-17706 10-31)

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Data being acquired over a 1200 km path in northern Greenland, to characterize the polar meteor scatter channel, are described. The data include both propagation and projected communication statistics. The propagation statistics include arrival rates and duty cycle as a function of frequency and received signal level. The communication statistics include estimates of the performance of a number of candidate systems in terms of throughput and message delivery time, as a function of frequency, time-of-day, season, data rate, and modulation, for a specified bit-error-rate, message length, and packet size. Author

**N89-17748#** Hamburg Univ. (Germany, F.R.). Meteorologisches Inst.

**MONTE CARLO SIMULATION OF MULTIPLE SCATTERING EFFECTS OF MILLIMETER WAVES FROM RAIN FOR A BISTATIC RADAR** **c32**

P.-H. Voss and H. Jeske *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 9 p (For primary document see N89-17706 10-31)

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Within the scope of rain measurements with a bistatic dual-polarization radar, the influence of multiple scattering effects is discussed. The determination of multiple scattering intensities (up to sixth order) for frequencies of 33 and 94 GHz in dependence on rainfall rate, single scattering albedo, volume scattering coefficient, number of ground reflections, antenna beam widths, and dimensions of the rain volume was done by the aid of an efficient Monte Carlo algorithm. The results show that multiple scattering cannot be neglected interpreting the scattered electromagnetic field on the basis of the normal radar equation. The portion to total scattering can become more than 5 percent for shorter microwaves and stronger rain rates (say 50 mm/h). Author

**N89-17749#** Cambridge Univ. (England).

**REMOTE SENSING OF INTERPLANETARY SHOCKS USING A SCINTILLATION METHOD** **c93**

A. Hewish *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 6 p (For primary document see N89-17706 10-31)

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Energetic interplanetary disturbances originating at the Sun cause geomagnetic storms when they reach the Earth. The disturbances affect radio communication, damage electrical power grid networks, increase the atmospheric density and drag on satellites, and are accompanied by showers of energetic particles which present radiation hazards to manned spacecraft. A ground-based method for locating and tracking transients in interplanetary space long before they reach the Earth is described. Continuous observations of transients during a two year period near sunspot maximum have demonstrated the potential of the technique for predicting geomagnetic storms and new information on the zones of the solar disk from which transients originate was given. The latter contradicts some widely held theories in solar-terrestrial physics and shows that a major revision of ideas is needed. Contrary to expectations, it was found that open-magnetic field regions known as coronal holes are the dormant sources of the most powerful interplanetary shocks. This result conflicts with the solar flare theory of geomagnetic storms. Author

**N89-17750#** Boston Univ., MA. Dept. of Astronomy.

**MAGNETIC STORM EFFECTS ON F LAYER IRREGULARITIES NEAR THE AURORAL OVAL** **c46**

Jules Aarons and Alan S. Rodger (British Antarctic Survey, Cambridge, England ) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 10 p Sponsored in part by ONR, Washington, DC and National Environment Research Council, United Kingdom (For primary document see N89-17706 10-31)

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The effect of F layer irregularities on transionospheric transmissions and fading at HF at the equatorial, auroral, and polar latitudes was documented. Little was done on morphology and physics of irregularities noted at subauroral latitudes, in the vicinity of the plasmapause. The intensities of the irregularities are considerably less than those observed at equatorial and high latitude regions. A study was made of F layer irregularities for the month of October 1981 using a series of scintillation and spread F measurements between 0 and 70 W. This included F layer intersections at subauroral as well as auroral latitudes. In the data set a comparison was made of scintillation on one propagation path, in the Northern Hemisphere, and spread F data at a Southern Hemisphere conjugate position, the Argentine Islands. Correlation was obtained on those nights when scattering was noted over several hours. The major irregularity activity periods were separated. The separation of irregularity occurrence at subauroral latitudes into cases associated with magnetic activity and cases when magnetic activity was quiet does not allow for simple modeling or statistical ordering. Ordering by Dst rather than Ap yields the best results. During magnetic activity, the irregularities may be convected from high latitudes or created by penetration of the electric field to lower latitudes. During the recovery phase it is proposed that ring current energies supply the ultimate source of the irregularity production at F layer heights. Author

**N89-17751#** Lowell Univ., MA. Center for Atmospheric Research.

**SPECULAR SCATTER: A NEW MECHANISM FOR IONOSPHERIC BACKSCATTER** **c46**

Gary S. Sales *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 8 p (For primary document see N89-17706 10-31)

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Recent investigation into backscatter from ionospheric irregularities at high frequencies (3 to 30 MHz) has indicated that the usual scatter mechanism requiring orthogonality with the field-aligned irregularities in the E and F region of the ionsophere is not sufficient to explain all the observations. Assuming field aligned electron density irregularities, ray tracing shows that clutter originates in the region where the ray becomes perpendicular to the earth's magnetic field lines within the ionosphere. The intensity of these irregularities can be described in terms of delta N/N, the fractional deviation from the ambient electron density. The actual distribution of electron density fluctuations is described using a power law spectrum with an exponent of $n = 2$. As will be shown, the orthogonality condition can always be satisfied in the F region of the ionosphere at mid and high latitudes near the reflecting point where the rays have become near-horizontal. The orthogonal clutter mechanism is restricted to F-region altitudes near the reflection point for obliquely propagating HF signals. In the auroral ionosphere, in addition, the E-region irregularities are expected to be intense and can contribute to the overall ionospheric clutter through the mechanism of specular scatter. This scattering mechanism was not considered before and will be described in detail. Finally, the specular scatter mechanism permits effective scatter at a wide range of altitudes throughout the F and E regions of the ionosphere. Author

**N89-17752#** Air Force Geophysics Lab., Hanscom AFB, MA.

**IONOSPHERIC SCINTILLATIONS AND IN-SITU MEASUREMENTS AT AN AURORAL LOCATION IN THE EUROPEAN SECTOR** **c46**

Santimay Basu, Sunanda Basu, Eileen MacKenzie, and Dan Weimer (Regis Coll., Weston, MA.) *In* AGARD, Scattering and Propagation

in Random Media Mar. 1988 12 p Sponsored in part by Defense Nuclear Agency, Washington, DC (For primary document see N89-17706 10-31)
(Contract F19628-86-K-0038)
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The orbiting HiLat satellite launched by the Defense Nuclear Agency in 1983 offered an opportunity for studying the ionospheric scintillation parameters in relation to the in-situ measurements of ionization density, drift velocity, field-aligned current, and particle precipitation during the sunspot minimum period. The results of such a morphological study performed by the Air Force Geophysics Laboratory based on their observations at the auroral oval station of Tromso, Norway are discussed. The dynamics of the spatial and temporal extent of this region are illustrated in the invariant latitude/magnetic local time grid. The geometrical enhancement of scintillations observed during the alignment of the propagation path with the local magnetic L-shell is shown to be the most consistent and conspicuous feature of scintillations in the nighttime auroral oval. The steepening of phase spectral slope in this region is indicative of the presence of L-shell aligned sheet-like irregularities at long scale lengths. The seasonal variation of total electron content (TEC) determined from the differential Doppler measurements of HiLat transmissions is discussed in relation to in-situ density measurements at 830 km. The results are also utilized to illustrate the dependence of ionospheric structure parameters on short-term variability of solar activity during the sunspot minimum period. Special effort is made to illustrate that the joint study of scintillation/TEC and in-situ parameters provides an insight into the nature of magnetospheric coupling with the high latitude ionosphere. Author

**N89-17753*#** Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
**PROPOSAL FOR A LUNAR TUNNEL-BORING MACHINE Final Report**
Christopher S. Allen, David W. Cooper, David Davila, Jr., Christopher S. Mahendra, and Michael A. Tagaras 5 May 1988 67 p
(Grant NGT-21-002-080)
(NASA-CR-184746; NAS 1.26:184746) Avail: NTIS HC A04/MF A01 CSCL 13B

A need exists for obtaining a safe and habitable lunar base that is free from the hazards of radiation, temperature gradient, and micrometeorites. A device for excavating lunar material and simultaneously generating living space in the subselenian environment was studied at the conceptual level. Preliminary examinations indicate that a device using a mechanical head to shear its way through the lunar material while creating a rigid ceramic-like lining meets design constraints using existing technology. The Lunar Tunneler is totally automated and guided by a laser communication system. There exists the potential for the excavated lunar material to be used in conjunction with a surface mining process for the purpose of the extraction of oxygen and other elements. Experiments into lunar material excavation and further research into the concept of a mechanical Lunar Tunneler are suggested. Author

**N89-17754#** Army Tank-Automotive Command, Warren, MI.
**STUDY OF PASSIVE FUEL TANK INERTING SYSTEMS FOR GROUND COMBAT VEHICLES Final Report, Mar. - Sep. 1988**
Steven J. McCormick, Peter F. Motzenbecker, and Michael J. Clauson Sep. 1988 60 p
(TACOM-TR-13385) Avail: NTIS HC A04/MF A01 CSCL 13B

Many flammable materials are carried aboard combat vehicles, including fuel, hydraulic fluid, and munitions. A fire involving any of these can lead to destruction of the vehicle and injury to the crew. Ground combat vehicles have relied on fire extinguishing systems to protect the vehicles and crew, while aircraft use passive inerting techniques as well as fire extinguishing systems. The apparent disparity between ground combat vehicles and aircraft has caused the U.S. Congress to direct the Secretary of the Army to examine the use of passive, multiple-hit, fuel tank inerting systems in tracked and wheeled vehicles. This report examines passive fuel tank inerting techniques and provides an assessment of their applicability to ground combat vehicles. The extent of the hazard posed by the combat vehicle fuel tanks has been defined. The adequacy of the technology in reducing this hazard is evaluated for each technique considered. The current technology for the suppression of fires in and from vehicle fuel tanks available to and in use by the armed services, other government agencies, the private sector, and foreign armed services has also been examined. Attention was restricted to passive systems (systems which do not require any mechanical or electrical activation) which can suppress multiple occurrences of fire. Both fuel tank fillers and systems which surround the fuel tanks were considered. A review of currently available passive fuel tank inerting technologies has shown that the majority of these techniques are not effective for ground combat vehicles considering the large antiarmor threats. A significant quantity of testing has been conducted which bears this out. An exception to this are fuel tank jackets which show great promise in improving ground combat fire survivability. Futher development work must be done before this approach can be integrated into production vehicles or retrofitted into fielded vehicles. Proper fuel system and vehicle design, in conjunction with fire extinguishing systems, are still the most effective means available to limit the damage caused by combat and peacetime fuel fires. Author

# 32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

**N89-17755** New South Wales Univ., Kensington (Australia).
**EXACT MAXWELLIAN SOLUTIONS OF BEAMS OF ELECTROMAGNETIC WAVES Ph.D. Thesis**
Lorenzo Cicchitelli Feb. 1988 3 p
Avail: Issuing Activity

From the basic differential form of Maxwell's equations in vacuo, the beam propagation phenomena was investigated. The criteria that beamed electromagnetic waves are constituted from purely transverse components is not consistent with Maxwell's equations. The beamed electromagnetic radiation must necessarily contain longitudinal fields for an exact Maxwellian formulation. Starting from a combination of Maxwell's laws for electromagnetic fields in a vacuum, and assuming that basically the propagation of a beam is wave like consisting of a time and spatial harmonic part, conditions are obtained on the cross sectional profile and mode functions. By using a simplified model for a beam, differential equations were developed for the field components. Solving these equations using a Generalized Frobenius method results in a solution which is based on the superposition of plane waves. The natural extention to this consequence is the plane wave spectrum method. Author

**N89-17756*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ADAPTIVE FEED ARRAY COMPENSATION SYSTEM FOR REFLECTOR ANTENNA SURFACE DISTORTION**
Roberto J. Acosta and A. Zaman 1989 7 p Proposed for presentation at the 1989 IEEE AP-S International Symposium and URSI Radio Science Meeting, San Jose, CA, 26-30 Jun. 1989
(NASA-TM-101458; E-4568; NAS 1.15:101458) Avail: NTIS HC A02/MF A01 CSCL 20N

The feasibility of a closed loop adaptive feed array system for compensating reflector surface deformations has been investigated. The performance characteristics (gain, sidelobe level, pointing, etc.) of large communication antenna systems degrade as the reflector surface distorts mainly due to thermal effects from a varying solar flux. The compensating systems described in this report can be

used to maintain the design performance characteristics independent of thermal effects on the reflector surface. The proposed compensating system employs the concept of conjugate field matching to adjust the feed array complex excitation coefficients. Author

**N89-17757#** National Oceanic and Atmospheric Administration, Washington, DC. National Environmental Satellite, Data, and Information Service.

**ADJUSTMENT OF MICROWAVE SPECTRAL RADIANCES OF THE EARTH TO A FIXED ANGLE OF PROPAGATION**

D. Q. Wark Dec. 1988 46 p

(NOAA-TR-NESDIS-43) Avail: NTIS HC A03/MF A01

Data from the Special Sensor, Meteorological/Temperature (SSM/T) on the Defense Meteorological Satellite Program satellites F7, F8, and F9 have been used to calculate limb-adjustment coefficients to transform all data to the values they would have in a vertical view. It is demonstrated that radiance temperatures averaged in one-degree latitudinal belts at different angles of view can be used successfully to compute the coefficients, provided the sample is large. The channels used in each adjustment are limited to those which have meaningful physical relations. It is shown that the latitudinal means used in the least-squares solution for the coefficients represent typical individual sets of measurements. It is further shown that increased noise and errors due to errors of estimate of the coefficients are of little or no concern. A seasonal update of the coefficients for two satellites is performed with beneficial results. Author

**N89-17758#** Technische Univ., Berlin (Germany, F.R.). Fachbereich Elektrotechnik.

**INVESTIGATIONS OF THE MODELING OF DIGITAL MOBILE RADIO COMMUNICATION CHANNELS Ph.D. Thesis [UNTERSUCHUNGEN ZUR MODELLIERUNG DIGITALER MOBILFUNKKANAELE]**

Jing Ming Kuang 1988 150 p In GERMAN

(ETN-89-93485) Avail: NTIS HC A07/MF A01

The statistical error behavior of binary mobile radio communication channels and their description by modeling based on simple digital channel models were investigated. The digital channel models are based on stationary Markov chains, and are fully characterized by a few parameters. Channel modeling consists of the determination of channel parameters by numerical optimization methods in such a way that the error statistics of the channel model agree with the measured bit error rates. Channel modeling methods are compared. It is shown that the different channel models are well suited for the modeling of different bit error measuring data, depending on the conditions; the most suited model has to be selected for each case. ESA

**N89-17759#** Universitaet der Bundeswehr, Neubiberg (Germany, F.R.). Fachbereich Elektrotechnik.

**A CONTRIBUTION TO THE DESCRIPTION OF THE PROPERTIES OF PSEUDO-RANDOM PHASE SHIFT MODULATED CW RADAR SYSTEMS Ph.D. Thesis [EIN BEITRAG ZUR BESCHREIBUNG DER EIGENSCHAFTEN VON PSEUDO-ZUFAELLIG PHASENSPRUNGMODULIERTEN CW-RADARSYSTEMEN]**

Burkard Wigger 1988 176 p In GERMAN

(ETN-89-93487) Avail: NTIS HC A09/MF A01

The systems characteristics of pseudonoise phase shift keying (PNPSK) modulated CW radars are described. The systems concept of a PNPSK-modulated CW radar is outlined. The degrading effects of distortions on the autocorrelation function (ACF) is mathematically described. It is shown that the ACF of the PNPSK-signal can be simply described by an approximation using the Gauss function, and that asymmetries and sidepeaks in the ACF are due to linear distortions with straight frequency dependence of the group delay. The occurring nonlinear distortions allow the determination of the amplitude of apparent targets. The measured data allow statements concerning the occurrence and the amplitude of sidepeak in the ACF during the variation of the period of the pseudorandom sequence. ESA

**N89-17760#** Karlsruhe Univ. (Germany, F.R.). Fakultaet fuer Elektrotechnik.

**EFFECT OF LASER NOISE ON THE RECEIVER CHARACTERISTICS OF COHERENT OPTICAL COMMUNICATION SYSTEMS, WITH THE EXAMPLE OF A 140 MBIT/SEC FREQUENCY-SHIFT KEYING HETERODYNE RECEIVER Ph.D. Thesis [EINFLUSS DES LASERRAUSCHENS AUF DIE EMPFANGSEIGENSCHAFTEN KOHAERENTER OPTISCHER NACHRICHTENSYSTEME AM BEISPIEL EINES 140 MBIT/S FSK-HETERODYNEMPFAENGERS]**

Christian Fritzsche 1987 84 p In GERMAN

(ETN-89-93492) Avail: NTIS HC A05/MF A01

A frequency-shift-keying (FSK) heterodyne receiver was developed and built in order to verify a theory on the effects of additive and phase noise on the bit error take in FSK. The principles of optical superheterodyning, modulation and demodulation methods, and noise sources are introduced. Mathematical modelling and solution methods are reviewed. The theory of the two-filter FSK receiver and time of propagation discriminator are outlined. A comparative discussion of the different modulation and demodulation methods is presented; the power penalty due to phase noise is compared for the different heterodyne and homodyne methods. The experimental results obtained with the 140 Mbit/sec FSK heterodyne system at 0.85 micrometer confirm the theoretical predictions. ESA

**N89-17761#** Research Inst. of National Defence, Linkoeping (Sweden). Dept. of Information Technology.

**LOCAL EARLY WARNING SYSTEMS WITH LS-RADAR**

Erik Arvidsson Sep. 1988 26 p In SWEDISH; ENGLISH summary

(FOA-E-30008-3.3; ISSN-0281-9937; ETN-89-93744) Avail: NTIS HC A03/MF A01; Swedish Defense Research Establishment, Box 1165, S-581 11 Linkoping, Sweden, 50 Swedish crowns

A complement to the local optical early warning system is described. The LS system (LS = optical early warning station) is suggested, using simple marine radars equipped with MTI circuits. It is possible for land based MTI-radar to separate moving target echoes from ground echoes. The LS-radar early warning system gives directly a warning to neighboring local command centers. Advantages of LS radar systems are: good range also for targets above sea level, good working in case of rain or clouds, low costs per supervised sq mile, and possibility to insert an acoustic alarm. One of the disadvantages is high weight and volume. ESA

**N89-17762#** Ecole Nationale Superieure des Telecommunications, Paris (France). Dept. Communications.

**SIMPLE COHERENT RECEIVERS FOR PARTIAL RESPONSE CONTINUOUS PHASE MODULATION**

Ghassan Kawas-Kaleh 1988 28 p Presented at the Global Telecommunications Conference, Tokyo, Japan, Nov. 1987 and at the Symposium in Information Theory and its Applications, Enoshima, Japan, Nov. 1987

(ENST-86C006; ISSN-0751-1337; ETN-89-94104) Avail: NTIS HC A03/MF A01

By using a pulse amplitude modulation representation of the binary continuous phase modulation signals, an optimum Viterbi sequence detector and a near optimum Viterbi receiver with low complexity was developed. For the modulation index 0.5, where a linear receiver can be used, a minimum mean-squared error linear receiver filter is derived. Their performance is analyzed. The Gaussian minimum shift keying signal (GMSK) is used for illustration. It is shown that a GMSK receiver consisting of 2 matched filters and a four-state Viterbi algorithm performs with less than 0.24 dB degradation compared with the optimal receiver. The linear receiver is optimum for all values of Eb/No (bit energy to noise one-sided spectral density ratio). A design method for its receiver filter is given. The filter is equivalent to a cascade of a matched filter and a Wiener filter estimator. Upper and lower bounds for the bit-error probability are calculated. Simulation results which confirm the analysis are also given. ESA

**N89-17763#** Ecole Nationale Superieure des Telecommunications, Paris (France). Dept. Signal.
**PHONETIC RECOGNITION OF NATURAL SPEECH BY NONSTATIONARY MARKOV MODELS**
Alessandro Falaschi (Rome Univ., Italy ) Apr. 1988 33 p
(ENST-88D012; ISSN-0751-1345; ETN-89-94105) Avail: NTIS HC A03/MF A01

A speech recognition system based on statistical decision theory, viewing the problem as the classical design of a decoder in a communication system framework is outlined. Statistical properties of the language are used to characterize the allowable phonetic sequence inside the words, while trying to capture allophonic phoneme features into functional-dependent acoustical models with the aim of utilizing them as word segmentation cues. Experiments prove the utility of an explicit modeling of the intrinsic speech nonstationarity in a statistically based speech recognition system. The nonstationarity of phonetic chain statistics and acoustical transition probabilities can be easily taken into account, yielding recognition improvements. The use of inside syllable position dependent phonetic models does not improve recognition performance, and the iterative Viterbi training algorithm seems unable to adequately valorize this kind of acoustical modeling. As a direct consequence of the system design, the recognized phonetic sequence exhibits word boundary marks even in absence of pauses between words, thus giving anchor points to the higher level parsing algorithms needed in a complete recognition system. ESA

**N89-17764#** Ecole Nationale Superieure des Telecommunications, Paris (France).
**PREDICTION AND MARKOVIAN REPRESENTATION OF STEADY VECTORIAL PROCESSES ON Z(2). USE OF TWO-DIMENSIONAL SPECTRAL ESTIMATION TECHNIQUES IN ANTENNA DATA PROCESSING Ph.D. Thesis [PREDICTION ET REPRESENTATION MARKOVIENNES DES PROCESSUS STATIONNAIRES VECTORIELS SUR Z2. UTILISATION DE TECHNIQUES D'ESTIMATION SPECTRALE 2-D EN TRAITEMENT D'ANTENNE]**
Philippe Loubaton Jul. 1988 296 p In FRENCH
(ENST-88E012; ISSN-0751-1353; ETN-89-94106) Avail: NTIS HC A13/MF A01

Contributions to the study of random steady fields on the complex plane are presented, including the extension of the Wiener-Kolmogorov linear prediction theory, the processes generated by finite difference equations, and the problem of extension of a two-dimensional covariance to its application in spectral estimation. The application described is a two-dimensional spectral estimation technique for antenna image data processing. The field in analysis is supposed to be formed by the superposition of plane wave front sources and the process is a two index steady process. It is shown that with adequate modeling of the delay of the various signals, the spectral support may be identified from a finite number of points of the autocorrelation function. ESA

**N89-17765#** Ecole Nationale Superieure des Telecommunications, Paris (France). Dept. Signal.
**COMPILATION OF A TARGET DICTIONARY AND UTILIZATION FOR INFERENCE IN ACOUSTIC PHONETIC DECODING [CONSTITUTION D'UN DICTIONNAIRE DE CIBLES ET UTILISATION POUR L'INFERENCE EN DECODAGE ACOUSTICO-PHONETIQUE]**
Sophie Taillanter 1988 65 p In FRENCH
(ENST-88H003; ISSN-0751-1361; ETN-89-94107) Avail: NTIS HC A04/MF A01

The obtainment of a dictionary of acoustic targets, the learning phase of the recognition process, was carried out by time decomposition of a large set of diphones. The technique helps to identify acoustic events such as coarticulation, which are difficult to evaluate by conventional decoding. In the recognition phase, acoustic targets obtained from a test recording are identified using the elements of the dictionary. Recognition strategies were tested. The difficulties are not entirely solved. Some of the procedures are abandoned while others are selected for additional investigation. ESA

**N89-17766** British Broadcasting Corp., Kingswood (England). Engineering Div.
**IMPLEMENTATION OF AMPLITUDE MODULATION COMPANDING IN THE BBC MF NATIONAL NETWORKS**
C. P. Bell, C. R. Harison, R. K. Lawrence, W. I. Manson, A. R. Preedy, and W. F. Williams Dec. 1988 26 p
(BBC-RD-1988/15) Avail: Issuing Activity

The introduction of new transmitter designs in the LF, MF, and HF broadcast bands has not only improved efficiency directly, but permitted use of modulation-dependent control systems which can themselves reduce operating costs without loss of coverage. This Report describes the design and development of one such modulation-controlled system, known as Amplitude Modulation Companding (AMC). In the method both carrier and sideband levels are progressively reduced as the modulation level is increased, this effect being compensated in the receiver by the normal action of the automatic gain control circuit. Extensive trials of a fully developed system for 50 kW MF transmitters have achieved input power savings of between 20 and 40 percent, depending on program content. This is achieved with imperceptible loss of coverage and further savings may be practible. Author

**N89-17767*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**UNIVERSAL TEST FIXTURE FOR MONOLITHIC mm-WAVE INTEGRATED CIRCUITS CALIBRATED WITH AN AUGMENTED TRD ALGORITHM**
Robert R. Romanofsky and Kurt A. Shalkhauser Mar. 1989 42 p Presented at the 13th International Conference on Infrared and mm-Waves, Honolulu, Hawaii, 5-9 Dec. 1988
(NASA-TP-2875; E-3983; NAS 1.60:2875) Avail: NTIS HC A03/MF A01 CSCL 09C

The design and evaluation of a novel fixturing technique for characterizing millimeter wave solid state devices is presented. The technique utilizes a cosine-tapered ridge guide fixture and a one-tier de-embedding procedure to produce accurate and repeatable device level data. Advanced features of this technique include nondestructive testing, full waveguide bandwidth operation, universality of application, and rapid, yet repeatable, chip-level characterization. In addition, only one set of calibration standards is required regardless of the device geometry. Author

**N89-17768#** Massachusetts Inst. of Tech., Cambridge. Lab. for Information and Decision Systems.
**DATA NETWORKS RELIABILITY Final Report, 1984 - 1986**
Robert G. Gallager 3 Oct. 1988 17 p
(Contract N00014-84-K-0357)
(AD-A200695; LIDS-FR-1821) Avail: NTIS HC A03/MF A01 CSCL 12G

The research from 1984 to 1986 on Data Network Reliability had the objective of developing general principles governing the reliable and efficient control of data networks. The research was centered around three major areas: congestion control, multiaccess networks, and distributed asynchronous algorithms. The major topics within congestion control were the use of flow control algorithms. The major topics within congestion control were the use of flow control to reduce congestion and the use of routing to reduce congestion. The major topics within multiaccess networks were the communication properties of multiaccess channels, collision resolution, and packet radio networks. The major topics within asynchronous distributed algorithms were failure recovery, time vs. communication tradeoffs, and the general theory of distributed algorithms. GRA

**N89-17769#** Stevens Inst. of Tech., Hoboken, NJ. Dept. of Electrical Engineering and Computer Science.
**IMPEDANCE MATCHING FOR HIGH SPEED OPTICAL COMMUNICATION Final Report, Apr. - Oct. 1987**
Henry Zmuda Jun. 1988 48 p
(Contract F30602-81-C-0185)
(AD-A200753; RADC-TR-88-92) Avail: NTIS HC A03/MF A01 CSCL 25C

This technical report details several methods of providing low

Standing Wave Ratio (SWR), low loss, broadband microwave impedance matching for direct modulation of a laser diode. The report addresses group delay performance of matching networks and provides several Computer-Aided-Designs (CAD) solutions to impedance matching of the laser diodes in both active and passive systems. GRA

**N89-17770#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
**DISPLAY SIZE: A LITERATURE SURVEY AND A STUDY WITH SLR (SIDE-LOOKING RADAR) IMAGERY Summary Report, Jun. 1986 - Jul. 1988**
Herschel C. Self Sep. 1988 64 p
(AD-A200852; AAMRL-TR-88-001) Avail: NTIS HC A04/MF A01 CSCL 17I

A literature survey of studies relevant to display size is followed by discussions of display size geometry, size calculation equations and selection of display size for imaging displays. A display size study was done. Display size was varied by using small(5 x 5 ), medium (10 x 10 ) and large (15 x 15 ) film transparencies of Side Looking Airborne Radar (SLAR) pictures viewed on a light table. The targets, one per picture, were 12 airfields, 12 railroad yards, and 12 tank farms. All targets were adequate in size for easy visual examination. The observers were 72 SAC and TAC radar navigators. The only briefing information for each picture was the type of target to be detected. Each observer saw each scene only once. Target detection time was measured. No target was difficult for all observers, but some were difficult for some. Average response times on individual scenes were sometimes quickest on the small display, and sometimes quickest for the medium or large display. Airfield and railroad yards were found quickest on the small display, the size for which response to tank farms was slowest. The results demonstrate that, when sensor and display resolutions and target image size are adequate, the display size yielding the quickest target detection for unbriefed targets depends upon the type of target. GRA

**N89-17771#** California Univ., Berkeley. Electronics Research Lab.
**CONFORMAL TIME DOMAIN FINITE DIFFERENCE METHOD OF SOLVING ELECTROMAGNETIC WAVE SCATTERING Final Report, 1 May 1984 - 30 Apr. 1988**
Kenneth K. Mei 18 Oct. 1988 10 p
(Contract DAAG29-84-K-0067)
(AD-A200921; ARO-20951.4-GS) Avail: NTIS HC A02/MF A01 CSCL 12A

The objective of this research project is to develop simple solution techniques for time domain differential equations, with conforming boundaries, air-ground interfaces and proper absorbing boundary conditions. GRA

**N89-17772#** Naval Research Lab., Washington, DC.
**A DESIGN CONCEPT FOR RELIABLE MOBILE RADIO NETWORKS WITH FREQUENCY-HOPPING SIGNALING**
Anthony Ephremides 30 Sep. 1988 36 p
(AD-A200928; NRL-9137) Avail: NTIS HC A03/MF A01 CSCL 25B

The design of a packet radio network must reflect the operational requirements and environmental constraints to which it is subject. In this report we outline those features that distinguish the High Frequency (HF) Intra Task Force (ITF) Network from other packet radio networks, and we present a design concept for this network that encompasses organizational structure, waveform design, and channel access. Network survivability is achieved through the use of distributed network control and frequency-hopping spread-spectrum signaling. We show how the execution of the fully distributed Linked Cluster Algorithm can enable a network to reconfigure itself when it is affected by connectivity changes such as those resulting from jamming. Additional resistance against jamming is provided by frequency hopping, which leads naturally to the use of Code Division Multiple Access (CDMA) techniques that permit the simultaneous successful transmission by several users. Distributed algorithms that exploit CDMA properties have been developed to schedule contention-free transmissions for much of the channel access in this network. Contention-based channel access protocols can also be implemented in conjunction with the Linked Cluster network structure. The design concept presented in this report provides a high degree of survivability and flexibility to accommodate changing environment conditions and user demands. GRA

**N89-17773#** Royal Signals and Radar Establishment, Malvern (England).
**THE APPLICATION OF A DISTRIBUTED ARRAY PROCESSOR (DAP) TO LINEAR ASSIGNMENT PROBLEMS IN RADAR TRACKING**
A. J. Stanley, P. Simpson, and J. B. Roberts Jul. 1988 22 p
(AD-A200941; RSRE-MEMO-4213; BR107778) Avail: NTIS HC A03/MF A01 CSCL 17I

A Distributed Array Processor (DAP) is an SIMD parallel processing machine composed of 1024 one-bit Processing Elements (PEs). This Memorandum examines the application and detailed performance of this machine to the linear assignment problem with data arrays up to 256x256 in size. The linear assignment problem is used in ESM, radar tracking, and other fields where it is necessary to assign data from two or more classes to each other. Since the assignment problem is solved by a computationally intensive algorithm a comparison is made between the DAP and a serial machine, a VAX 8600, to assess the speed gains obtained from the DAP by executing instructions in parallel. The results show that the DAP is far faster at solving this problem than the VAX by up to two orders of magnitude. GRA

**N89-17774#** Naval Postgraduate School, Monterey, CA.
**DESIGN INVESTIGATION FOR A MICROSTRIP PHASED ARRAY ANTENNA FOR THE ORION SATELLITE M.S. Thesis**
Mark B. Smith Jun. 1988 199 p
(AD-A200943) Avail: NTIS HC A09/MF A01 CSCL 22B

Students at the Naval Postgraduate School are designing a general purpose mini-satellite that can be launched from a Get-Away-Special cannister located in the cargo bay of the Space Shuttle and will be compatible with expendable launch vehicles as well. This thesis defines preliminary antenna systems and the design parameters for the telemetry system of the ORION mini-satellite. These antenna design parameters may be used for investigations of various proposed antenna systems and the design parameters also allow for trade-off studies with the mission capabilities and subsystems of the satellite. An investigation is made into the feasibility of using conformal microstrip patch array antennas for the telemetry, tracking and command (TT&C) systems. It is necessary to have two separate microstrip patch array antennas for the telemetry system: one uplink and one downlink antenna. The microstrip patch array antenna can operate as either an omnidirectional antenna or a directional antenna by changing the phase of the individual patch feeds. This feature gives the microstrip patch array antenna more flexibility for meeting the needs of potential users. GRA

**N89-17775#** Naval Research Lab., Washington, DC.
**PERFORMANCE EVALUATION OF FREQUENCY-HOPPED SPREAD SPECTRUM MULTI-HOP NETWORKS Interim Report**
J. W. Gluck and Evaggelos A. Geraniotis (Maryland Univ., College Park.) 2 Nov. 1988 55 p
(AD-A200950; NRL-MR-6354) Avail: NTIS HC A04/MF A01 CSCL 25B

Primary and secondary multiple-access interference processes are characterized for multi-hop packet radio networks, in which users are assumed to be Poisson-distributed in the plane and to use frequency hopped spread-spectrum signaling with a receiver-oriented assignment of frequency-hopping patterns. The throughput per node and the average forward progress are then evaluated for frequency-hopped multi-hop networks that employ Random Forward Routing with fixed transmission radius (RFR) and most forward progress routing with fixed transmission radius (MFR). The optimal average number of neighbors and transmission

radius are derived for these cases when Reed-Solomon forward-error-control coding with minimum distance decoding or binary convolutional coding with Viterbi decoding is employed. GRA

**N89-17776#** Stanford Telecommunications, Inc., Santa Clara, CA.
**ADAPTIVE BEAM ANTENNA COMMUNICATION NETWORKS Final Report, Aug. 1985 - Feb. 1986**
D. Thomas Magill May 1988 75 p
(Contract F19628-85-C-0145)
(AD-A200953; STI-TR-63091; RADC-TR-88-108) Avail: NTIS HC A04/MF A01 CSCL 25E

This study was devoted to assessing the feasibility of using an adaptive beam antenna system with a communication network to improve system performance. This assessment entailed developing beam acquisition algorithms, determining their practicality, and estimating their performance. Task objectives were to: (1) develop an integrated adaptive beam communication system. (2) determine the applicability of an adaptive beam antenna system, (3) determine the required adaptive beam antenna characteristics, and (4) define a demonstration system to be developed in Phase 2 of this effort. GRA

**N89-17777#** Stevens Inst. of Tech., Hoboken, NJ.
**MULTIDIMENSIONAL SIGNAL PROCESSING Final Report, Jan. - Nov. 1987**
Sankar Basu Jun. 1988 128 p
(Contract F30602-81-C-0185)
(AD-A200954; RADC-TR-88-116) Avail: NTIS HC A07/MF A01 CSCL 25E

Properties of various multidimensional polynomials arising in studies of passive (lossless) discrete multidimensional systems are investigated. Reactance Schur polynomials and immittance Schur polynomials occurring respectively as the denominators (and numerators) of discrete reactance functions and discrete positive functions are introduced and their properties studied. The role of these polynomials in scattering or immittance descriptions of passive discrete time domain multiports are brought out. The interrelation between classes of multidimensional polynomials arising in discrete systems and the corresponding classes of polynomials in the context of continuous systems is also studied via the mechanics of bilinear transformation. The problem of structurally passive synthesis of multidimensional digital filters of the quarter-plane casual type as an interconnection of more elementary building blocks directly in the discrete domain has been addressed via the factorization of the chain matrix, the hybrid matrix and the transfer function matrix associated with a prescribed multidimensional lossless two-port. By exploiting recent results on the discrete domain representation of such matrices a generalized lossless two-port matrix has been introduced to present all three factorizations in a unified setting. Necessary and sufficient conditions for factorability as well as algorithm for computing these factors when they exist are obtained. GRA

**N89-17778#** Naval Postgraduate School, Monterey, CA.
**A STUDY OF SECOND AND THIRD ORDER MODELS FOR THE TRACKING SUBSYSTEM OF A RADAR GUIDED MISSILE M.S. Thesis**
John W. Williams Jun. 1988 139 p
(AD-A200970) Avail: NTIS HC A07/MF A01 CSCL 17G

Missile and target parameters used in second and third order modeling of the tracking subsystem used in radar guided guided missiles are studied. Guidance methods are analyzed to determine which method is optimum in a search for an ideal missile. Target parameters which have an effect on the missile tracking system are analyzed and a target acceleration probability model is discussed. A two dimensional third order tracking model is simulated utilizing a Kalman filter for target parameter estimation and prediction. Linear second and third order tracking models are simulated and compared with the third order Kalman filter tracker. It is concluded that a proportional navigation guidance method, with a nonlinear third order tracking Kalman filter, is the better model. Benefits of using a nonlinear third order Kalman filter may not overide the cost and complexity of implementation of the model. GRA

**N89-17779#** Duke Univ., Durham, NC. Graduate School of Business Administration.
**THE DATA LINK LAYER: TWO IMPOSSIBILITY RESULTS**
Nancy Lynch, Yishay Mansour, and Alan Fekete May 1988 25 p
(Contracts N00014-83-K-0125; N00014-85-K-0168; NSF CCR-86-11442)
(AD-A200983; MIT/LCS/TM-355) Avail: NTIS HC A03/MF A01 CSCL 25E

The data link layer in a layered communication network is designed to ensure reliable data transfer over a noisy physical channel. Formal specifications are given for physical channels and data links, in terms of I/O automata. Based on these specifications, two impossibility results are proved. First, no data link protocol can tolerate crashes of the host processors on which the protocol runs. Second, any data link protocol constructed to use an arbitrary non-FIFO physical channel requires unbounded headers. GRA

**N89-17780#** Duke Univ., Durham, NC. Graduate School of Business Administration.
**POLYCHANNEL SYSTEMS FOR MASS DIGITAL COMMUNICATION**
David K. Gifford Jul. 1988 31 p
(Contract N00014-83-K-0125)
(AD-A200988; MIT/LCS/TR-420) Avail: NTIS HC A03/MF A01 CSCL 25E

We describe a new type of distributed computer system that looks beyond workstation and local area network assumptions towards the time when computers will be used by everyone at both home and the office. This new system is designed to provide sophisticated information services to an entire metropolitan area. We have combined digital broadcast channels and duplex communication channels in a polychannel system that uses predicate based database content labels to automatically route queries. Our thesis is that a polychannel system produces substantial cost and system scaling advantages while retaining the flexibility of client-server style duplex communication. Experimental data from a two year test of the Boson Community Information System system with hundreds of users supports this thesis. GRA

**N89-17781#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**STUDIES OF TARGET DETECTION ALGORITHMS THAT USE POLARIMETRIC RADAR DATA**
L. M. Novak, M. B. Sechtin, and M. J. Cardullo 12 Oct. 1988 57 p
(Contract F19628-85-C-0002)
(AD-A201043; TT-71; ESD-TR-88-180) Avail: NTIS HC A04/MF A01 CSCL 17I

This report describes algorithms which make use of polarimetric radar information in the detection and discrimination of targets in a ground clutter background. The Optimal Polarimetric Detector (OPD) is derived; this algorithm processes the complete Polarization Scattering Matrix (PSM) and provides the best possible detection performance from polarimetric radar data. Also derived is the best linear polarimetric detector, the Polarimetric Matched Filter (PMF), and the structure of this detector is related to simple polarimetric target types. New polarimetric target and clutter models are described; these models are used to predict the performance of the OPD and the PMF. The performance of these algorithms is compared to that of simpler detectors that use only amplitude information to detect targets. Finally, the ability to discriminate between target types by exploiting differences in polarimetric scattering properties is discussed. GRA

**N89-17782#** Naval Research Lab., Washington, DC.
**BOUNDS ON DOPPLER FREQUENCY ESTIMATION IN CORRELATED NONSTATIONARY GAUSSIAN NOISE Interim Report**
Feng-Ling Lin and Ben H. Cantrell 23 Aug. 1988 18 p
(AD-A201052; NRL-9140) Avail: NTIS HC A03/MF A01
CSCL 17K

The maximum likelihood estimates of target Doppler frequencies after target detection in the presence of correlated nonstationary Gaussian noise are presented. The Cramer-rao bounds on the Doppler for the nonstationary process are derived. It is found that in general the root-mean-square errors of the maximum likelihood estimates of the Doppler shift are very close to the Cramer-Rao bounds derived here. GRA

**N89-17783#** Harry Diamond Labs., Adelphi, MD.
**HIGH-FREQUENCY MODULATION AND FIBER-OPTIC LINKS FOR PHASED ARRAYS Final Report, Aug. 1987 - Mar. 1988**
Fred Semendy and Emanuel Katzen Oct. 1988 20 p
(AD-A201136; HDL-TR-2151) Avail: NTIS HC A03/MF A01
CSCL 17H

Direct modulation and detection studies were performed using various laser diodes from 2 to 22 GHz. A LiNbO3 traveling wave Mach-Zehnder interferometer was used for external modulation. The modulated beams were coupled into an optical fiber, demodulated by fast detectors, and spectrum analyzed. Attempts were also made to obtain higher order harmonics after direct modulation of the laser diodes by making use of the nonlinear behavior of the lasers. However, very high frequencies beyond K band could not be detected because of the limitations of the detectors. GRA

**N89-17784** Politecnico di Milano (Italy). Dipartimento di Elettronica.
**DATA AND THEORY FOR A NEW MODEL OF THE HORIZONTAL STRUCTURE OF RAINCELLS FOR PROPAGATION APPLICATIONS. A COMPREHENSIVE METEOROLOGICALLY-ORIENTED METHODOLOGY FOR THE PREDICTION OF WAVE PROPAGATION PARAMETERS IN TELECOMMUNICATION APPLICATIONS BEYOND 10 GHz**
1988 62 p Submitted for publication
(Rept-86-033; ETN-89-93724) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

A large population of radar measured ground raincells is used to devise and assess a raincell model for telecommunication applications. An approach based on the model for the prediction of propagation parameters (such as rain attenuation, site diversity gain, interference by rain scattering, etc) in telecommunication application beyond 10 GHz is presented. For individual titles, see N89-17785 through N89-17786.

**N89-17785** Politecnico di Milano (Italy). Dipartimento di Elettronica.
**DATA AND THEORY FOR A NEW MODEL OF THE HORIZONTAL STRUCTURE OF RAINCELLS FOR PROPAGATION APPLICATIONS**
C. Capsoni, F. Fedi (Fondazione Ugo Bordoni, Rome, Italy ), C. Magistroni, A. Paraboni, and A. Pawlina *In its* Data and Theory for a New Model of the Horizontal Structure of Raincells for Propagation Application. A Comprehensive Meteorologically-Oriented Methodology for the Prediction of Wave Propagation Parameters in Telecommunication Applications 1988 (For primary document see N89-17784 10-32)
Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

A large population of radar measured ground raincells is used to devise and assess a raincell model for telecommunication applications. The model is based on cells of exponential profile (which is shown to reproduce best the point rainrate cdf); rotational and biaxial symmetries are considered for the horizontal cross sections. The proposed model contains analytical expressions for the joint probability densities of the parameters which define the cell, i.e., peak rain intensity, cell size, and axial ratio. An algorithm for adapting the model to the characteristics of any given site is given. This algorithm requires as input the local cumulative distribution of point rainfall and provides the spatial number densities (i.e., the average number of cells per square km and per unit range of the parameters) which this distribution would produce. The model offers the possibility of predicting the statistics of many propagation parameters (such as attenuation of interference by rain scattering) which are determined by the raincell characteristics and their frequency of occurrence. ESA

**N89-17786** Politecnico di Milano (Italy). Dipartimento di Elettronica.
**A COMPREHENSIVE METEOROLOGICALLY-ORIENTED METHODOLOGY FOR THE PREDICTION OF WAVE PROPAGATION PARAMETERS IN TELECOMMUNICATION APPLICATIONS BEYOND 10 GHz**
C. Capsoni, F. Fedi (Fondazione Ugo Bordoni, Rome, Italy ), and A. Paraboni *In its* Data and Theory for a New Model of the Horizontal Structure of Raincells for Propagation Applications. A Comprehensive Meteorologically-Oriented Methodology for the Prediction of Wave Propagation Parameters in Telecommunication Applications 1988 (For primary document see N89-17784 10-32)
Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

An approach for the prediction of propagation parameters (such as rain attenuation, site diversity gain, interference by rain scattering etc) based on a statistical model of the rain horizontal structure, whose parameters can be determined on the basis of the local statistical distribution of the point rainfall intensity is presented. A test of the ability of this method in predicting attenuation statistics is performed using data collected in Europe with the satellites SIRIO and OTS. The excellent results encourage the application of the model to the statistical prediction of other parameters pertaining to propagation. ESA

**N89-17709#** Polytechnic Univ., Farmingdale, NY. Dept. of Electrical Engineering.
**GEOMETRICAL THEORY OF DIFFRACTION FOR HIGH-FREQUENCY COHERENCE FUNCTIONS IN WEAKLY RANDOM MEDIUM WITH INHOMOGENEOUS BACKGROUND PROFILE**
R. Mazar and L. B. Felsen *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 16 p (For primary document see N89-17706 10-31)
(Contract F49620-85-C-0028)
Copyright Avail: NTIS HC A23/MF A01

**N89-17710#** Colorado School of Mines, Golden. Center for Wave Phenomena.
**MULTIPLE SCATTERING FROM ROUGH SURFACES**
John A. DeSanto *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 10 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17712#** Royal Signals and Radar Establishment, Malvern (England).
**MARKOV RANDOM FIELDS: A STRATEGY FOR CLUTTER MODELLING**
Stephen P. Luttrell *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 8 p (For primary document see N89-17706 10-31)
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**N89-17713*#** Texas Univ., Arlington. Wave Scattering Research Center.
**A SCATTERING MODEL FOR FORESTED AREA**
M. A. Karam and A. K. Fung *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 9 p (For primary document see N89-17706 10-31)
(Grant NAG9-115)
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**N89-17715#** Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.
**THE ENHANCEMENT EFFECT OF THE BACKSCATTERED INTENSITY IN A RANDOM MEDIUM**
C. C. Yang and K. C. Yeh (Illinois Univ., Urbana.) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 11 p (For primary document see N89-17706 10-31)
(Grants NSF ATM-83-12175; NSF ECS-83-11345)
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**N89-17717#** Royal Signals and Radar Establishment, Malvern (England).
**HIERARCHICAL SCATTERING MODELS**
E. Jakeman *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 11 p (For primary document see N89-17706 10-31)
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**N89-17719#** Illinois Univ., Urbana-Champaign.
**SPACE-TIME STATISTICS OF WAVES PROPAGATING THROUGH A DEEP PHASE SCREEN**
S. J. Franke and C. H. Liu *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 16 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17720#** National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
**LINE-OF-SIGHT MILLIMETER WAVE PROPAGATION CHARACTERISTICS**
S. F. Clifford, R. J. Hill, R. B. Fritz, R. A. Bohlander, and R. W. McMillan (Georgia Inst. of Tech., Atlanta.) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 7 p (For primary document see N89-17706 10-31)
(Contract MIPR-122-85)
Copyright Avail: NTIS HC A23/MF A01

**N89-17723#** Forschungsinstitut der Deutschen Bundespost, Darmstadt (Germany, F.R.).
**A PRECIPITATION SCATTER EXPERIMENT AT 30 GHz**
Heinz Schmiedel and Alfred Ochs *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 8 p (For primary document see N89-17706 10-31)
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**N89-17724#** National Telecommunications and Information Administration, Boulder, CO.
**OBSERVED PHASE DELAY THROUGH RAIN AT 96 GHz**
Kenneth C. Allen *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 11 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17725#** Technische Hogeschool, Delft (Netherlands). Faculty of Electrical Engineering.
**FM-CW RADAR REMOTE SENSING OF HYDROMETEORS**
L. P. Ligthart and J. S. vanSinttruyen *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 15 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17726#** Thomson-CSF, Velizy (France). Centre d'Applications Radars.
**MODELING OF ELECTROMAGNETIC WAVE AND SEA SURFACE INTERACTION [MODELISATION DE L'INTERACTION ENTRE UNE ONDE ELECTROMAGNETIQUE ET LA SURFACE DE LA MER]**
Michel Fournier *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 14 p In FRENCH (For primary document see N89-17706 10-31)
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**N89-17727#** Memorial Univ. of Newfoundland, St. Johns. Faculty of Engineering and Applied Science.
**ROUGH SURFACE PROPAGATION AND SCATTER WITH APPLICATIONS TO GROUND WAVE REMOTE SENSING IN AN OCEAN ENVIRONMENT**
John Walsh and Satish K. Srivastava *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 15 p Sponsored by Canadian Dept. of National Defence and Natural Sciences and Engineering Research Council of Canada (For primary document see N89-17706 10-31)
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**N89-17728#** Thessaloniki Univ. (Greece). Dept. of Electrical Engineering.
**WAVE-TILT SOUNDING OF TROPOSPHERIC DUCTS ABOVE THE SEA**
D. P. Chrissoulidis and E. E. Kriezis *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 12 p (For primary document see N89-17706 10-31)
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**N89-17729#** Royal Signals and Radar Establishment, Malvern (England).
**I-BAND MULTIPATH PROPAGATION OVER THE SEA SURFACE**
C. J. Baker and K. D. Ward *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 5 p (For primary document see N89-17706 10-31)
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**N89-17730#** Rennes Univ. (France). Dept. Antennes.
**MEASUREMENT AND MODELING OF 36 GHz SEA REFLECTION PHENOMENA [ETUDE EXPERIMENTALE ET MODELISATION DU PHENOMENE DE REFLEXION SUR LA MER A 36 GHZ]**
Yvonick Hurtaud, Claude Terret, Jean-Pierre Daniel, and Alain Junchat (Centre d'Electronique de l'Armement, Bruz, France ) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 14 p In FRENCH (For primary document see N89-17706 10-31)
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**N89-17731#** Naval Research Lab., Washington, DC. Ionospheric Effects Branch.
**RANDOM PROPAGATION THROUGH THE LONGWAVE CHANNEL**
F. J. Kelly, F. J. Rhoads, and M. D. Andrews (Interferometrics, Inc., Vienna, VA.) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 27 p (For primary document see N89-17706 10-31)
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**N89-17732#** National Telecommunications and Information Administration, Boulder, CO. Inst. for Telecommunication Sciences.
**MODELING OF WIDEBAND HF CHANNELS**
Martin Nesenbergs *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 16 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17733#** National Telecommunications and Information Administration, Boulder, CO. Inst. for Telecommunication Sciences.
**PROPAGATION AND PERFORMANCE MEASUREMENTS OVER A DIGITAL TROPOSCATTER COMMUNICATIONS LINK**
John J. Lemmon *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 13 p Sponsored by Department of the Army, Washington, DC (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17734#** National Telecommunications and Information Administration, Boulder, CO. Inst. for Telecommunication Sciences.
**MEASUREMENT, MODELING AND SIMULATION OF LOS MICROWAVE CHANNELS**
James A. Hoffmeyer and Lewis E. Vogler *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 16 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17735#** Emmanuel Coll., Boston, MA.
**STRUCTURES OF DENSITY AND VELOCITY FLUCTUATIONS IN THE AURORAL OVAL AND THEIR IMPACT ON COMMUNICATION AND RADAR SYSTEMS**
Sunanda Basu, Santimay Basu, W. R. Coley, and N. C. Maynard (Air Force Geophysics Lab., Hanscom AFB, MA.) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 14 p (For primary document see N89-17706 10-31)
(Contract F19628-86-K-0038)
Copyright Avail: NTIS HC A23/MF A01

**N89-17736#** Telettra S.p.A., Chieti (Italy).
**IMPULSE RESPONSE MEASUREMENTS AND CHARACTERIZATION OF WIDEBAND VHF RADIO LINES**
P. LoMuzio, G. Guidotti, N. Benvenuto, and S. Pupolin (Padua Univ., Italy ) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 14 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17738#** Cambridge Univ. (England). Ocean Acoustics Group.
**CROSS-FREQUENCY CORRELATION OF INTENSITY FLUCTUATIONS IN THE PHASE-CHANGING MEDIA**
Sarah J. Miller *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 4 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17739#** Laboratoire Central de Telecommunications, Paris (France).
**MODELING ELECTROMAGNETIC WAVE PROPAGATION THROUGH A STRONGLY-FLUCTUATING IONIZED MEDIUM BY THE PHASE SCREEN METHOD [MODELE DE PROPAGATION D'UNE ONDE ELECTROMAGNETIQUE DANS UN MILIEU IONISE A FORTES FLUCTUATIONS PAR LA METHODE DES ECRANS DE PHASE]**
Y. Beniguel and B. Gibert (Aerospatiale Etablissement des Mureaux, France ) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 11 p In FRENCH (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17743#** Messina Univ. (Italy). Istituto di Struttura della Materia.
**SELECTIVE EXTINCTION OF A DISPERSION OF SINGLE AND AGGREGATED LAYERED SPHERES**
F. Borghese, P. Denti, R. Saija, O. I. Sindoni (Chemical Research and Development Center, Aberdeen Proving Ground, MD.), and G. Toscano *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 4 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17744#** Societe Mothesim, Le Plessis-Robinson (France).
**ELECTROMAGNETIC REFLECTIVITY IN NON-HOMOGENEOUS CONTINUOUS RANDOM MEDIA WITH CYLINDRICAL SYMMETRY [REFLECTIVITE ELECTROMAGNETIQUE D'UN MILIEU ALEATOIRE INHOMOGENE CONTINU A SYMETRIE CYLINDRIQUE]**
G. Muller and F. Molinet *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 12 p In FRENCH (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17746#** New Mexico State Univ., Las Cruces. Dept. of Physics.
**NON-LINEAR EFFECTS ON THE ATMOSPHERIC TRANSMISSION OF HIGH-FLUX ELECTROMAGNETIC BEAMS**
R. L. Armstrong *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 3 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17747#** Rome Air Development Center, Hanscom AFB, MA. Applied Electromagnetics Div.
**A STATISTICAL ANALYSIS OF POLAR METEOR SCATTER PROPAGATION IN THE 45 TO 104 MHz BAND**
M. J. Sowa, J. M. Quinn, J. E. Rasmussen, P. A. Kossey, and J. C. Ostergaard (Danish Research Center for Applied Electronics, Hoersholm.) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 9 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17748#** Hamburg Univ. (Germany, F.R.). Meteorologisches Inst.
**MONTE CARLO SIMULATION OF MULTIPLE SCATTERING EFFECTS OF MILLIMETER WAVES FROM RAIN FOR A BISTATIC RADAR**
P.-H. Voss and H. Jeske *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 9 p (For primary document see N89-17706 10-31)
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**N89-18399*#** National Aeronautics and Space Administration, Washington, DC.
**COMMUNICATIONS TECHNOLOGY**
Martin M. Sokoloski *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 31-47 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 17B

# 33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

**N89-17787#** Oak Ridge National Lab., TN.
**DESIGN PRINCIPLES FOR HIGH-FREQUENCY MICROWAVE CAVITIES**
Hal D. Kimrey and Mark A. Janney 1988 6 p Presented at the Spring Meeting of the Materials Research Society, Reno, NV, 4 Apr. 1988
(Contract DE-AC05-84OR-21400)
(DE89-001875; CONF-880408-39) Avail: NTIS HC A02

The characteristics of untuned cavities are determined for microwave processing of alumina. Alumina is a low-loss ceramic that is difficult to heat in the lower microwave region. System efficiency is determined as a function of cavity and workpiece size, frequency, and temperature. With operation at 28 GHz, a cavity applicator can be designed which is capable of generating uniform fields at high efficiency and with a reasonable size.

DOE

**N89-17788#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation.
**CAMAC CONTROLLED COINCIDENCE CIRCUITS**
V. M. Grebenyuk, Yu. A. Kozhevnikov, and A. V. Selikov 1987 6 p In RUSSIAN; ENGLISH summary
(DE88-704596; JINR-13-87-846) Avail: NTIS (US Sales Only) HC A02/MF A01

The CAMAC coincidence circuits with control of a resolving

time (0 to 16 ns) and input's delays (0 to 2 ns) with 60 ps pitch are described. Each unit contains one 8-input or two 4-input coincidence circuits. The 100 ps time resolution and 50 MHs internal performance is obtained. DOE

**N89-17789#** California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Chemical Sciences Div.
**SODIUM/BETA'-ALUMINA/ORGANOSULFUR BATTERIES OPERATING AT INTERMEDIATE TEMPERATURES**
Steven J. Visco and Lutgard C. DeJonghe Oct. 1988 15 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 28 Nov. - 2 Dec. 1988
(Contract DE-AC03-76SF-00098)
(DE89-004792; LBL-26061; CONF-881155-27) Avail: NTIS HC A03/MF A01

Concurrent with impressive advances in advanced batteries operating at high temperatures such as the Na/Na2S sub x and Li/FeS systems, have been concerns over safety and reliability of such batteries. Accordingly, various efforts have been made to offer alternative high specific energy/power batteries operating at reduced temperatures. However, since electrode kinetics and mass transport processes in batteries are thermally activated, lower temperature systems often present a compromise between lower power output, and enhanced reliability, safety, and economic factors. Fortunately, lower temperature systems also offer far more flexibility in cell design, allowing geometries with higher electrode surface area than would be feasible with high temperature systems, thereby reducing the necessary current densities for acceptable power output. The sodium/organosulfur cells discussed in the following paper are based on the well known Na/beta'-alumina/Na2S sub x battery technology. However, in the present cells the sodium polysulfide electrode which has an operating temperature of 300 to 350 C has been replaced with an organosulfur electrode which is limited at the low temperature limit by the melting point of sodium (approx. 100 C). DOE

**N89-17790#** Argonne National Lab., IL. Chemical Technology Div.
**LITHIUM/DISULFIDE CELLS CAPABLE OF LONG CYCLE LIFE**
T. D. Kaun, T. F. Holifield, and W. H. DeLuca 1988 10 p Presented at the Electrochemical Society Fall Meeting, Chicago, IL, 9 Oct. 1988
(Contract W-31-109-eng-38)
(DE89-003947; CONF-881061-11) Avail: NTIS HC A02/MF A01

The lithium-alloy/disulfide cell has undergone improvements to provide a very stable, high performance Upper-Plateau (UP) FeS2 electrode. Prismatic UP FeS2 cell tests (12 to 24 Ah capacity) with a LiCl-LiBr-KBr eutectic electrolyte have demonstrated 1000 deep discharge cycles at 400 C with less than a 20 percent drop in capacity and without reduced power capability. Previous lithium-alloy/disulfide cells, which were based on a two voltage-plateau FeS2 electrode and LiCl-KCl eutectic electrolyte had a life expectancy of only 100 cycles. Both time- and cycle-related capacity loss mechanisms have been eliminated with the improved cell design. In addition, new cell design features of overcharge tolerance and overdischarge safeguarding enhance battery durability. The performance prospects of a Li-alloy/UP FeS2 battery for an IDSEP van application are discussed. A specific energy of 150 Wh/kg for this battery after 1000 cycles of operation is projected. DOE

**N89-17791#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**AN ENVELOPE-FOLLOWING METHOD FOR THE EFFICIENT TRANSIENT SIMULATION OF SWITCHING POWER AND FILTER CIRCUITS**
K. Kundert, J. K. White, and A. L. Sangiovanni-Vincentelli Aug. 1988 12 p Presented at the International Conference on Computer Aided Design, Santa Clara, CA, 7-10 Nov. 1988
(Contract N00014-87-K-0825)
(AD-A200772; VLSI-MEMO-88-467) Avail: NTIS HC A03/MF A01 CSCL 10B

The transient behavior of circuits like switching power converters and switched capacitor filters are expensive to simulate because these circuits are clocked at a frequency whose period is orders of magnitude smaller than the time interval of interest to the designer. It is possible to reduce the simulation time without compromising accuracy by exploiting the property that the behavior of such a circuit in a given high frequency clock cycle is similar, but not identical, to the behavior in the preceding and following cycles. In particular, the envelope of the high-frequency clock can be followed by accurately computing the circuit behavior over occasional cycles. In this paper the implementation of such an envelope-following method that is particularly efficient for switching power and filter circuits is described, and results demonstrating the method's effectiveness are presented. GRA

**N89-17792#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**A MIXED FREQUENCY-TIME APPROACH FOR DISTORTION ANALYSIS OF SWITCHING FILTER CIRCUITS: REVISION**
K. Kundert, J. K. White, and A. L. Sangiovanni-Vincentelli Oct. 1988 20 p
(Contract N00014-87-K-0825)
(AD-A200773; VLSI-MEMO-88-480) Avail: NTIS HC A03/MF A01 CSCL 09A

Designers of switching filter circuits are often interested in steady-state and intermodulation distortion due to both static effects, such as nonlinearities in the capacitors, and dynamic effects, such as the charge injection during MOS transistor switching or slow operational amplifier settling. Steady-state distortion can be computed using the circuit simulation program SPICE, but this approach is computationally very expensive. Specialized programs for switched capacitor filters can be used to rapidly compute steady-state-distortion, but do not consider dynamic effects. In this paper we present a new mixed frequency-time approach for computing both steady-state and intermodulation distortion. The method is both computationally efficient and includes both static and dynamic distortion sources. The method has been implemented in a C program, Nitswit, and results from several examples are presented. GRA

**N89-17793#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**ACCELERATING RELAXATION ALGORITHMS FOR CIRCUIT SIMULATION USING WAVEFORM-NEWTON AND STEP-SIZE REFINEMENT**
R. A. Saleh, J. K. White, A. R. Newton, and A. L. Sangiovanni-Vincentelli Oct. 1988 28 p Sponsored in part by NERC of Canada, IBM Co., Phillips, Hewlett-Packard, Texas Instruments and MICRO
(Contract N00014-87-K-0825)
(AD-A200774; VLSI-MEMO-88-481) Avail: NTIS HC A03/MF A01 CSCL 09A

A new relaxation algorithm for circuit simulation that combines the advantages of iterated timing analysis (ITA) and waveform-relaxation (WR) is described. The method is based on using an iterative step-size refinement strategy with a waveform-relaxation-Newton (WRN) algorithm. All three relaxation techniques, ITA, WR, and WRN, are compared and experimental results that indicate the strengths and weaknesses of the methods are presented. In addition, a new covergence proof for the waveform-Newton method for systems with nonlinear capacitors is provided. Finally, it is shown that the step-refined WRN algorithm can be implemented on a parallel processor in such a way that not only can different subsystems be processed in parallel but in addition, the solution at different timepoints of the same subsystem can be computed in parallel. GRA

**N89-17794#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**A MIXED FREQUENCY-TIME APPROACH FOR FINDING THE STEADY-STATE SOLUTION OF CLOCKED ANALOG CIRCUITS**
K. Kundert, J. K. White, and A. L. Sangiovanni-Vincentelli Mar. 1988 16 p

(Contract N00014-87-K-0825)
(AD-A200778; VLSI-MEMO-88-444) Avail: NTIS HC A03/MF A01 CSCL 09A

Performing detailed simulation of clocked analog circuits (e.g., switched-capacitor filters and switching power supplies) with circuit simulation programs like SPICE is computationally very expensive. In this paper we present a new, more efficient, method for computing the detailed steady-state solution of clocked analog circuits. The method exploits the property of such circuits that the waveforms in each clock cycle are similar but not exact duplicates of the proceeding or following cycles. Therefore, by computing accurately a few selected cycles, the entire steady-state solution can be constructed efficiently. GRA

**N89-17795#** Utah Univ., Salt Lake City. Dept. of Chemistry.
**THE BEHAVIOR OF DISK ELECTRODES. OPTICAL IMAGING OF THE CONCENTRATION DISTRIBUTION OVER A DISK ELECTRODE UNDER GALVANOSTATIC CONDITIONS SPECIES SELECTIVE GAS CHROMATOGRAPHIC DETECTORS**
**Technical Report No. 117, Sep. 1987 - Jul. 1988**
John Daschbach, Stanley F. Simpson, Joel M. Harris, Martin Fleischmann (Southampton Univ., England ), and Stanley Pons 15 Jul. 1988 26 p Submitted for publication
(Contract N00014-83-K-0470)
(AD-A200840) Avail: NTIS HC A03/MF A01 CSCL 07D

In this paper, we describe the theoretical and experimental determination of the integrated time dependent concentration distribution of an electrogenerated species over a disk electrode embedded in an insulated plane. We have derived this result for the case of constant applied flux (chronopotentiometry). The experimental technique used for observing the integrated concentration distribution over the electrode was imaging by a low noise charge coupled device camera with time and spatial resolution of approximately 20ms and 20 microns respectively. The experiment demonstrates the contribution of the tertiary current distribution across the surface of the electrode. GRA

**N89-17796#** Utah Univ., Salt Lake City. Dept. of Chemistry.
**THE BEHAVIOR OF MICRODISK AND MICRORING ELECTRODES. CHRONOPOTENTIOMETRY AND LINEAR SWEEP AMPEROMETRY AT A MICRODISK ELECTRODE**
**Technical Report No. 124, Sep. 1987 - Jul. 1988**
L. M. Abrantes, Martin Fleischmann (Southampton Univ., England), L. J. Li, Marvin Hawkins, Joseph W. Pons, John Daschbach, and Stanley Pons 15 Jul. 1988 33 p
(Contract N00014-83-K-0470)
(AD-A200841) Avail: NTIS HC A03/MF A01 CSCL 09A

Chronopotentiometry has not been a widely used electroanalytical technique due to the severe distortion of the predicted shape of the response due to capacitative charging of the electrode. While the magnitude of the total current applied to the electrode can be controlled, the fraction of the total current driving the faradaic reaction is time dependent. As the electrode potential changes as the logarithm of the ratio of the surface activities of the redox couple, so must the magnitude of the capacitative charging current. It is well known that one of the major advantages of microelectrodes is the reduced magnitude of the capacitative component of the current (which varies as the area of the electrode) with respect to the faradaic component (which usually varies as a one dimensional characteristic length of the electrode, such as the radius of a disk). These devices should therefore be ideally suited to galvanostatic measurements. GRA

**N89-17797#** Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
**RETIMING SYNCHRONOUS CIRCUITRY**
Charles E. Leiserson and James B. Saxe Oct. 1988 31 p Prepared in cooperation with DEC Systems Research Center, Palo Alto, CA
(Contracts N00014-80-C-0622; N00014-76-C-0370)
(AD-A200978; MIT/LCS/TM-372) Avail: NTIS HC A03/MF A01 CSCL 25E

A circuit transformation called retiming is described in which registers are added at some points in a circuit and removed from others in such a way that functional behavior of the circuit as a whole is preserved. It is shown that retiming can be used to transform a given synchronous circuit into a more efficient circuit under a variety of different cost criteria. We model a circuit as a graph in which the vertex set V is a collection of combinational logic elements and the edge set E is the set of interconnections, each of which may pass through zero or more registers. We give an algorithm for determining an equivalent retimed circuit with the smallest possible clock period. We show that the problem of determining an equivalent retimed circuit with minimum state (total number of registers) is polynomial-time solvable. This result yields a polynomial-time optimal solution to the problem of pipelining combinational circuitry with minimum register cost. We also give a characterization of optimal retiming based on an efficiently solvable mixed-integer linear programming problem. GRA

**N89-17798#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**MODEL-BASED TROUBLESHOOTING OF DIGITAL SYSTEMS**
Walter C. Hanscher Aug. 1988 321 p
(Contract N00014-85-K-0124)
(AD-A201041; AI-TR-1074) Avail: NTIS HC A14/MF A01 CSCL 12I

This thesis describes a methodology, a representation, and an implementated program for troubleshooting digital circuit boards at roughly the level of expertise one might expect in a human novice. Existing methods for model-based troubleshooting have not scaled up to deal with complex circuits, in part because traditional circuit models do not explicitly represent aspects of the device that troubleshooters would consider important. For complex devices the model of the target device should be constructed with the goal of troubleshooting explicitly in mind. GRA

**N89-17799#** Idaho National Engineering Lab., Idaho Falls.
**AN ULTRASONIC PULSER/RECEIVER SYSTEM WITH EXTENDED DYNAMIC RANGE AND LOW DISTORTION**
L. S. Beller, L. C. Johnson, and S. C. Taylor 1988 6 p Presented at the Review of Progress in Quantitative Nondestructive Evaluation, La Jolla, CA, 31 Jul. 1988
(Contract DE-AC07-76ID-01570)
(DE89-005406; EGG-M-88159; CONF-880760-9) Avail: NTIS HC A02/MF A01

The increasing sophistication of quantitative ultrasonic techniques and signal processing requires signal electronics systems having performance characteristics which are significantly better than those of conventional designs. Better performance, in terms of extended signal dynamic range, stability, bandwidth, and signal distortion, is becoming essential for many applications in the laboratory and in the field; further, software control of large automated systems often requires specialized circuit configurations, which are not available. This paper addresses the design of an ultrasonic signal system which has proven very useful as the major signal-conditioning component in obtaining improved performance in large, automated ultrasonic systems. Extended dynamic range comes from improvements in the signal/noise ratio (SNR). Both terms in the ratio are addressed, increased sensitivity through pulser design, and noise primarily in receiver design and careful attention to circuit details. The system is entirely modular and includes provisions for software-driven gain control and random multiplexing of many channels. The key, and most difficult, elements in the system are the pulser and amplifier. The major part of the discussion will be on these elements and the rationale for their design, rather than on circuit details. Use of these elements in large automated systems and in laboratory investigations will also be discussed. DOE

**N89-17800#** Idaho National Engineering Lab., Idaho Falls.
**EVALUATION OF STATE-OF-CHARGE INDICATOR APPROACHES FOR EVs**
A. F. Burke 1988 11 p Presented at the Society of Automotive Engineers International Congress and Exposition, Detroit, MI, 29

Feb. 1988
(Contract DE-AC07-76ID-01570)
(DE89-005412; EGG-M-88341; CONF-880241-2) Avail: NTIS HC A03

Studies of battery management systems (BMS), including state-of-charge (SOC) algorithms, were performed in the Battery Test and Vehicle Dynamometer Laboratories at the INEL. The test and evaluation of the SOC algorithms indicated that the capacity rate dependent and adaptive approaches to determining battery SOC yielded RMS errors between the indicated and actual states-of-charge of less than 10 percent if battery temperature and aging effects were not dominate. The BMS tested were not sufficiently accurate and reliable to permit their use as the primary means of charge control during the various INEL test programs. Considerable progress has been made in the development of BMS, but further work is needed before the systems can be used with confidence in either the charge or discharge modes without careful attention from the user. DOE

**N89-17801#** Sandia National Labs., Albuquerque, NM. Battery Development Div.
**METAL SULFIDE FOR BATTERY APPLICATIONS**
Ronald A. Guidotti 1988 18 p Presented at the 92d National Western Mining Conference and Exhibition, Denver, CO, 8 Feb. 1989
(Contract DE-AC04-76DP-00789)
(DE89-005923; SAND-88-2873C; CONF-890209-1) Avail: NTIS HC A03/MF A01

A number of metal sulfides can be used in batteries as a cathode (reducible) material as part of an electrochemical couple to provide energy. There are a number of physical and chemical characteristics that can be evaluated for screening potential candidates for use in batteries. These include: cell potential vs. Li, thermal and chemical stability, electrical conductivity, allotropic form (phase), reaction kinetics during discharge, type of discharge mechanism, and material rechargeability. These are reviewed in general, with emphasis on sulfides of copper, iron, and molybdenum which are currently being used as cathodes in Li and Li-alloy batteries. The presence of impurities can adversely impact performance when naturally occurring sulfide minerals are used for battery applications. Sandia National Laboratories uses natural pyrite (FeS2) for its high-temperature, thermally activated Li(Si)/FeS2 batteries. The purification and processing procedures for the FeS2 involves both chemical and physical methods. Flotation was found to yield comparable results as HF leaching for removal of silica, but without the negative health and environmental concerns associated with this technique. DOE

**N89-17802#** Stanford Linear Accelerator Center, CA.
**RADIO FREQUENCY PULSE COMPRESSION**
Z. D. Farkas Dec. 1988 7 p Presented at the Workshop on Physics of Linear Colliders, Capri, Italy, 13-17 Jun. 1988
(Contract DE-AC03-76SF-00515)
(DE89-005967; SU-SLAC-PUB-4820; CONF-8806258-2) Avail: NTIS HC A02/MF A01

High gradients require peak powers. One possible way to generate high peak powers is to generate a relatively long pulse at a relatively low power and compress it into a shorter pulse with higher peak power. It is possible to compress before dc to RF conversion as is done for the relativistic klystron or after dc to RF conversion as is done with SLED. In this note only radio frequency pulse compression (RFPC) is considered. Three methods of RFPC will be discussed: SLED, BEC, and REC. DOE

**N89-17695#** Aeritalia S.p.A., Turin (Italy). Combat Aircraft Group.
**A STUDY TO OPTIMIZE THE CFRP-Al MECHANICAL JOINT IN ORDER TO REDUCE ELECTRICAL RESISTANCE**
F. Cipri and M. Pelosi *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 11 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

# 34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

**N89-17803** Arizona Univ., Tucson.
**CHARGE-COUPLED DEVICE OPTIMIZATIONS FOR ASTRONOMY Ph.D. Thesis**
Michael Patrick Lesser 1988 129 p
Avail: Univ. Microfilms Order No. DA8814256

In the past decade, charge coupled devices (CCDs) have rapidly become the astronomical imaging detector of choice for the visible and near-IR spectral regions. There are, however, several problems which have greatly reduced the availability of sufficient quality CCDs to the astronomical community. Methods are presented which can be used to optimize CCDs obtained from various manufacturers for astronomical observations. A new thinning technique which produces an optically flat surface across an entire CCD is demonstrated. A mounting technique which maintains a flat and stable imaging surface for thinned devices by bonding the CCD backside against a transparent glass support substrate is also demonstrated. The design of antireflection coatings for the near-UV through near-IR spectral regions is explained and demonstrated on silicon diodes, allowing quantum efficiencies as high as 90 pct to be obtained. Dissert. Abstr.

**N89-17804** Southampton Univ. (England).
**WAVE MOTION IN THICK DAMPED LAMINATED ORTHOTROPIC PLATES Ph.D. Thesis**
Rolandos Joannides 1987 292 p
Avail: Univ. Microfilms Order No. BRD-82115

Exact closed form solutions are presented for the harmonic plane wave motion in thick single and three layered isotropic/orthotropic plates together with the approximate solution for a general multilayerd orthotropic plate. These allow for transverse direct strain through the thickness of the plate together with shear deformation and transverse and longitudinal inertias in all layers. Studies are made of the wavespeeds, wavemodes, and the corresponding wave loss factors when some or all of the layers are damped. The forced harmonic response to an external harmonic pressure field with both normal and tangential components was also examined. The exact analyses solve the linear equations of equilibrium and compatibility for each layer. Hamilton's principle is used to set up the equations of motion. Special attention is given to plates with a lengthwise axis of symmetry, and extensive computed results are presented and discussed for the wavespeeds and loss factors of the many different types of waves which can exist. Where possible, the results from the approximate theories are compared with those from the exact theories, and also from previous approximate theories. Experimental methods are also developed to measure the high frequency properties of orthotropic composite materials. These are applied to a particular glass fiber reinforced plastic material and its dynamic mechanical properties are determined successfully up to a frequency of 20 kHz. Dissert. Abstr.

**N89-17805** Cincinnati Univ., OH.
**NUMERICAL SOLUTION OF UNSTEADY, COMPRESSIBLE, REDUCED NAVIER-STOKES EQUATIONS Ph.D. Thesis**
Sekaripuram Venkatad Ramakrishnan 1988 171 p
Avail: Univ. Microfilms Order No. DA8812679

The limits of applicability of the Reduced Navier-Stokes (RNS) equations are explored. Some steady flows with large separation and unsteady flows with vortex shedding are investigated with unsteady, compressible RNS equations. The line relaxation procedure previously developed to solve the steady RNS equations is extended to solve the unsteady equations. A modification of the standard line relaxation procedure that is more stable and efficient is presented. The five point coupled strongly implicit

procedure, employed in the study of the stream function vorticity form of the full NS equation, is modified to solve a nine point finite difference scheme. The usefulness of the RNS approximation in the study of steady flows with large separation and unsteady flows with vortex shedding is demonstrated by comparing some RNS solutions with available full NS calculations. The shock capturing capability of the RNS procedure is demonstrated for a model problem. A hysteresis effect leading to different steady and unsteady solutions for the same conditions is observed from the numerical studies of the flow past a finite flat plate at incidence. Dissert. Abstr.

**N89-17806#** Oak Ridge National Lab., TN.
**STEADY-STATE REFRIGERANT FLOW AND AIRFLOW CONTROL EXPERIMENTS CONDUCTED ON A CONTINUOUSLY VARIABLE SPEED AIR-TO-AIR HEAT PUMP**
W. A. Miller 1987 25 p Presented at the Annual Meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Nashville, TN, 28 Jun. 1987
(Contract DE-AC05-84OR-21400)
(DE89-001931; CONF-870620-12) Avail: NTIS HC A03

A continuously variable speed air-to-air split-system residential heat pump of nominal 2 3/4-ton (9.7-kW) capacity was instrumented and tested in the laboratory. The coefficient of performance (COP), capacity of the system, and component efficiencies were measured during steady-state heating- and cooling-mode operation. The indoor blower speed and the refrigerant subcooling at the condenser exit were varied at discrete compressor speeds to determine best COP as constrained by residence comfort requirements. Heating- and cooling-mode test results showed a 10 percent improvement in COP for operation with a variable area throttle as compared with a capillary tube throttle. Improved control of refrigerant flow and reduction of the indoor blower speed improved humidity control. As compared with results for capillary tube flow control, the sensible heat ratio was reduced from 0.95 to 0.77 at 15-Hz compressor speed. DOE

**N89-17807** Stanford Univ., CA.
**SOLVING NONLINEAR ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS USING SERIES EXTENSION METHOD. PART A: LAMINAR FLOW THROUGH A SLOWLY ROTATING STRAIGHT PIPE, AND, PART B: NATURAL CONVECTION INSIDE A HORIZONTAL CIRCULAR CYLINDER Ph.D. Thesis**
Kamyar Mansour 1988 258 p
Avail: Univ. Microfilms Order No. DA8815024

Two different problems in fluid dynamics were examined using the method of series extension. First, fully developed steady laminar flow through a pipe that is rotating slowly about a line perpendicular to its own axis was examined. The solution is expanded for low Reynolds numbers in powers of a single combined similarity parameter and the series extended to 34 terms by computer. Next, the two-dimensional problem of steady natural convection in a circular cavity filled with viscous fluid due to a cosine temperature variation on the boundary was considered. The solution was expanded for low Rayleigh number and extended to 27 terms by computer. Partial agreement with other investigations was achieved. Dissert. Abstr.

**N89-17808** California Univ., Berkeley.
**VISCOUS FLOW OF DROPS AND BUBBLES IN STRAIGHT AND CONSTRICTED TUBES Ph.D. Thesis**
Mario Joseph Martinez 1987 182 p
Avail: Univ. Microfilms Order No. DA8813991

The slow viscous flow of drops and bubbles through tubes of uniform and periodically varying cross sectional area is investigated. The axisymmetric problem is formulated as a boundary integral equation which is solved numerically for the boundary velocities and stresses. Interfacial tension along the fluid interface results in a jump in the normal stress proportional to the surface curvature. The unknown shape of the interface is determined as part of the full solution by applying the condition that the interface is a material surface. The boundary integral equation method is ideal for this type of problem and should be useful in analyzing other problems involving fluid interfaces. Dissert. Abstr.

**N89-17809** State Univ. of New York, Stony Brook.
**EXPERIMENTAL STUDY OF VORTEX STRUCTURE IN A PLANE MIXING LAYER Ph.D. Thesis**
Sanjay Vinayak Sherikar 1987 122 p
Avail: Univ. Microfilms Order No. DA8812796

Entrainment and mixing in shear layers are results of the behavior of large coherent structures that are formed in these flows. Therefore, an understanding of the structure of these large vortices is fundamental to the understanding and predictions of these flows. In this study, coherent structures in a plane shear layer were investigated. A new technique for cine flow visualization which uses reaction between NH3 and HCl was developed. This was used to visualize two flow situation; one with no reaction and only the motion of the passive interface is observed, and the other in which the flow has reaction in it. Development of a scheme to synchronize velocity measurements with simultaneous cine flow visualization allowed the study of individual coherent structures in the initial region of the mixing layer without any signal deterioration due to jitter and phase scrambling. Statistical properties of coherent structures in the region of interest from analysis of 100 movie frames are presented and discussed. Dissert. Abstr.

**N89-17810** Illinois Univ., Urbana-Champaign.
**A NEW NUMERICAL METHOD: ASYMPTOTICALLY SIMPLIFIED ITERATION METHOD WITH PATCHING AS APPLIED TO FREE AND MIXED CONVECTION HEAT TRANSFER Ph.D. Thesis**
Duan-Fan Wang 1988 239 p
Avail: Univ. Microfilms Order No. DA8815438

Conventional boundary layer analysis is restricted to problems in which the transverse momentum equation is not important and the streamwise diffusion terms in the momentum and energy equations are negligible. Full Navier-Stokes methods, on the other hand, are computationally expensive due to slow convergence and the lack of an economical means to simulate the infinity boundary condition. An efficient, exact solver of the full Navier-Stokes and energy equations Asymptotically Simplified Iteration Method with Patching (ASIMP) is presented. Iteration techniques appropriate for each region are obtained from considerations of the asymptotic behavior at high Reynolds numbers. For the inner flow, the solution is based on a Residual Correction Scheme with the residuals evaluated using a higher order finite difference formula, but with the corrections computed from an efficient, lower order marching solution scheme. For the outer flow, the analytical solution of the potential flow is utilized with a residual reduction scheme, the Momentum Sources Method. Free and mixed convection heat transfer for a simple geometry and a complex geometry with recirculation regions were investigated using the present method. Dissert. Abstr.

**N89-17811** Duke Univ., Durham, NC.
**FLOW OF A CONFINED VISCOUS FLUID DUE TO DEFORMATION OF A COMPLIANT BOUNDARY Ph.D. Thesis**
Mary Katherine Weaver 1987 167 p
Avail: Univ. Microfilms Order No. DA8813568

Two approaches, here termed Eulerian and Lagrangian, to the specification of a moving boundary surface are described and then the Eulerian boundary specification in the modeling of two-dimensional and axisymmetric compliant-boundary driven flow is emphasized. The motivation was an interest in the generation of suspension currents in a bioreactor vessel by the controlled deformation of a compliant portion of the bioreactor boundary. The Eulerian boundary treatment is applicable to viscous, as well as to inviscid, flow problems. The key to the method is expression of the boundary contour in terms of a scalar function of the spatial coordinates and time. The normal component of velocity at the boundary is obtained from the function through the use of classical kinematic formulas. The tangential component of boundary-point velocity can also be obtained, provided that the Eulerian specification of the boundary contour is augmented by specification

of the boundary strain-rate. Special cases are presented in which the boundary strain-rate is assumed to be of simple form, or in which specification of the strain-rate is unnecessary. Finite difference simulations are presented to illustrate the technique.
Dissert. Abstr.

**N89-17812** Princeton Univ., NJ.
**BOUNDARY LAYER RELAXATION FROM CONVEX CURVATURE Ph.D. Thesis**
Amy Elsa Alving 1988 177 p
Avail: Univ. Microfilms Order No. DA8819575

Convex curvature has promise as a means of viscous drag reduction because it has been shown to result in a decrease in skin friction. In order to improve the understanding of curvature effects and their potential for drag reduction, an examination was made of the flat plate relaxation behavior of a turbulent boundary layer recovering from 90 deg of strong convex curvature. Mean flow and one-point and multiple-point turbulence measurements were taken to document not only the relaxation of the skin friction and other mean flow parameters, but also the behavior of the turbulence. The results show that the mean flow and turbulence behaviors are quite different. In the mean, the boundary layer asymptotically approaches the unperturbed state, and at the last state it appears to fully recovered. The turbulence relaxation, however, occurs in several stages over a much longer distance. In addition, the ratios of the elements in the Reynolds stress tensor are distorted, and the multiple-point measurements indicate that the large scale structures at the last station are different from those in the unperturbed boundary layer. These results imply a reorganization of the large scale structure into a new quasi-stable orientation. Dissert. Abstr.

**N89-17813** Virginia Polytechnic Inst. and State Univ., Blacksburg.
**THE EFFICIENT USE OF VECTORIZED DIRECT SOLVERS IN COMPUTATIONAL FLUID DYNAMICS Ph.D. Thesis**
David Warren Riggins 1988 124 p
Avail: Univ. Microfilms Order No. DA8817417

The feasibility of using a vectorized banded direct solver for the compressible Euler and Navier-Stokes equations is examined for both single- and multi-grid strategies. A procedure is developed for comparing the computational effort required for the direct method with that of the vertical line Gauss-Seidel iteration scheme in order to provide a criteria for choosing between the two techniques. The direct method is shown to have a relatively wide range of application on a vector processor with large memory. Indeed, the primary limitation of the direct method at this time is machine memory. Results for both inviscid and viscous test problems over a range of Mach and Reynolds numbers are examined for two dimensions. Dissert. Abstr.

**N89-17814** Maryland Univ., College Park.
**APPLICATION OF A MEAN VORTICITY COVARIANCE TURBULENCE CLOSURE TO FLOW PAST THE AFT PART OF AN AXISYMMETRIC BODY Ph.D. Thesis**
Charles Mun Hong Dai 1988 156 p
Avail: Univ. Microfilms Order No. DA8818384

The Mean Vorticity Covariance (MVC) turbulence closure is derived with consideration of the relationship between Lagrangian and Eulerian statistics. Lagrangian correlation is shown to be defined in terms of a domain integral over a set of Eulerian correlations which are obtained concurrently at all positions in the flow field of interest. It is further demonstrated that a Langrangian correlation and an Eulerian correlation are equivalent in the case of homogeneous turbulence which forms the base for the MVC closure. A physical model which is based upon the simplifications made on the kinematics of the fluctuating part of the turbulent flow is proposed for the two-dimensional or the axisymmetric turbulent flow. A fully implicit finite difference technique is developed for the governing mean vorticity and covariance equations. The stream function equation is solved iteratively with the coupled equations. Dissert. Abstr.

**N89-17815** Illinois Inst. of Tech., Chicago.
**EXPERIMENTAL INVESTIGATION OF COHERENT STRUCTURES IN TURBULENT BOUNDARY LAYERS Ph.D. Thesis**
Candace E. Wark 1988 321 p
Avail: Univ. Microfilms Order No. DA8817458

The events which are responsible for the majority of the turbulence production in the near wall region of a bounded turbulent shear flow were investigated in both a regular and a flat plate manipulated boundary layer. The scaling of the bursting frequency was investigated for several heights using the quadrant, u-level and VITA detection techniques. The coherent structures associated with the bursting event were studied using the quadrant and shear stress detection techniques. All three velocity components were measured in a 3-D sampling volume around the point of detection. Conditional space time probability density distributions were calculated at all measurement locations, based on the occurrence of a turbulence producing event at the point of detection. The relation between the conditional structures and the long time correlations demonstrates the importance of these structures in the dynamics and the turbulence production process of the boundary layer. Dissert. Abstr.

**N89-17816** Stevens Inst. of Tech., Hoboken, NJ.
**NUMERICAL STUDY OF SECONDARY FLOWS IN CURVED DUCTS Ph.D. Thesis**
Nahmkeon Hur 1988 165 p
Avail: Univ. Microfilms Order No. DA8817331

The occurrence of secondary flow in curved ducts due to the centrifugal forces as well a small temperature effects can often significantly influence the volume flux and heat transfer rates. In the present work, the secondary flow of an incompressible viscous fluid in a curved duct with and without sidewall heating is studied by using a finite volume method. It is known that for low Dean numbers, the secondary flow is characterized by a pair of counter-rotating vortices. It is shown that as the Dean number increases, the secondary flow structure evolves into a double vortex pair for low aspect ratio ducts and roll-cells for ducts of high aspect ratio. Computations for turbulent flow were carried out using a nonlinear two-equation turbulence model. The model is used to predict secondary flows in straight and curved ducts. Comparison with available experimental results indicates good agreement.
Dissert. Abstr.

**N89-17817** Minnesota Univ., Minneapolis.
**NUMERICAL STUDY OF STABILITY OF FLUID FLOW Ph.D. Thesis**
Kanchan Moreshwar Kelkar 1988 250 p
Avail: Univ. Microfilms Order No. DA8820481

Stability of fluid motion is one of the central problems in fluid mechanics. The stability phenomena is examined where one type of laminar flow becomes unstable and evolves into another steady or unsteady laminar flow. Since analytical solution of the governing differential equations is virtually impossible, these equations are discretized using a finite difference method. Behavior of the solutions of these discretization equations is analyzed using various numerical techniques. Continuation methods are used to trace the steady solution branches. Linear stability of the steady solutions is analyzed by solving the linearized unsteady discretization equations for the perturbation quantities. A theoretical analysis of the three different time stepping techniques is presented. These numerical techniques are applied to study two problems of practical interest, namely natural convection in a shallow enclosure and external flow around a square cylinder. Dissert. Abstr.

**N89-17818#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**COMPUTATIONAL FLUID DYNAMICS, VOLUME 1**
1988 248 p Lecture series held in Rhode-Saint-Genese, Belgium, 7-11 Mar. 1988
(VKI-LS-1988-05-Vol-1; ISSN-0377-8312; ETN-89-93594) Avail: NTIS HC A11/MF A01

Finite element methods as a class of discrete approximations;

structured and unstructured grids; defect correction and nonlinear multigrid for the steady Euler equations; vortex methods for separated flows; and relaxation solution of steady flow equations were discussed. For individual titles, see N89-17819 through N89-17823.

**N89-17819#** GEC Power Engineering Ltd., Whetstone (England).
**FINITE ELEMENT METHODS AS A CLASS OF DISCRETE APPROXIMATIONS**
P. S. White *In* VKI, Computational Fluid Dynamics, Volume 1 1988 23 p (For primary document see N89-17818 10-34)
Avail: NTIS HC A11/MF A01

The Navier-Stokes equations are introduced, and finite element approaches to their solution are reviewed. Weighting functions and basis functions are classified. Criteria for chosing a particular method are suggested. ESA

**N89-17820#** GEC Power Engineering Ltd., Whetstone (England).
**STRUCTURED AND UNSTRUCTURED GRIDS: TWO CONTRASTED APPROACHES**
P. S. White *In* VKI, Computational Fluid Dynamics, Volume 1 1988 20 p (For primary document see N89-17818 10-34)
Avail: NTIS HC A11/MF A01

The types of mesh adopted in tackling the linear equations encountered in fluid dynamics are discussed. Two opposite approaches are considered: arbitrary distributions of very simple elements, and simple distributions of elements of a more complicated form. The former approach allows a very efficient implementation of explicit time-integration methods whereas the other shows promise of allowing an implicit time-integration which nevertheless leads to rapid linear solutions. The two-step explicit solution method, unstructured grids, regular rectangular grids and tensor product bases, and weak forms and discrete equations are covered. ESA

**N89-17821#** Center for Mathematics and Computer Science, Amsterdam (Netherlands).
**DEFECT CORRECTION AND NONLINEAR MULTIGRID FOR THE STEADY EULER EQUATIONS**
P. W. Hemker and B. Koren *In* VKI, Computational Fluid Dynamics, Volume 1 1988 57 p (For primary document see N89-17818 10-34)
Avail: NTIS HC A11/MF A01

The defect correction principle is explained, and multigrid approaches to compressible flow are introduced. Multigrid techniques for the first order discretization of the Euler equations are presented. Defect correction for higher order Euler computations is considered. Solution of Navier-Stokes equations is discussed. ESA

**N89-17822*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**VORTEX METHODS FOR SEPARATED FLOWS**
Philippe R. Spalart *In* VKI, Computational Fluid Dynamics, Volume 1 1988 64 p Previously announced as N88-26342 (For primary document see N89-17818 10-34)
Avail: NTIS HC A11/MF A01

The numerical solution of the Euler or Navier-Stokes equations by Lagrangian vortex methods is discussed. The mathematical background is presented and includes the relationship with traditional point-vortex studies, convergence to smooth solutions of the Euler equations, and the essential differences between two and three-dimensional cases. The difficulties in extending the method to viscous or compressible flows are explained. Two-dimensional flows around bluff bodies are emphasized. Robustness of the method and the assessment of accuracy, vortex-core profiles, time-marching schemes, numerical dissipation, and efficient programming are treated. Operation counts for unbounded and periodic flows are given, and two algorithms designed to speed up the calculations are described. ESA

**N89-17823#** Ghent Univ. (Belgium). Dept. of Machinery.
**RELAXATION SOLUTION OF STEADY FLOW EQUATIONS**
E. Dick *In* VKI, Computational Fluid Dynamics, Volume 1 1988 69 p Sponsored by the National Science Foundation, Belgium (For primary document see N89-17818 10-34)
Avail: NTIS HC A11/MF A01

Iterative solution of convection-diffusion steady flow equations is discussed. Positivity and discrete ellipticity are explained. Multigrid formulation of a relaxation method is outlined. The Cauchy-Riemann equations are presented. The incompressible Navier-Stokes equations are solved. Flux vector splitting and flux difference splitting for Euler equations are compared. ESA

**N89-17824#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**COMPUTATIONAL FLUID DYNAMICS, VOLUME 2**
1988 395 p Lecture series held in Rhode-Saint-Genese, Belgium, 7-11 Mar. 1988
(VKI-LS-1988-05-Vol-2; ISSN-0377-8312; ETN-89-93595) Avail: NTIS HC A17/MF A01

High resolution upwind formulations for the Navier-Stokes equations; compressible flow solvers using unstructured grids; real gases and hypersonic reentry; an implicit approximate factorization finite volume technique with improved accuracy for the compressible Navier-Stokes equations; and a fully implicit scheme for unsteady flow calculations solved by the approximate factorization technique were discussed. For individual titles, see N89-17825 through N89-17829.

**N89-17825#** Rockwell International Science Center, Thousand Oaks, CA.
**HIGH RESOLUTION UPWIND FORMULATIONS FOR THE NAVIER-STOKES EQUATIONS** **c02**
Sukumar R. Chakravarthy *In* VKI, Computational Fluid Dynamics, Volume 2 1988 106 p (For primary document see N89-17824 10-34)
Avail: NTIS HC A17/MF A01

State-of-the-art techniques for obtaining numerical solutions to compressible fluid flow problems are reviewed. The distinguishing features of this class of methods include Total Variation Diminishing (TVD) formulations and upwind discretization for the hyperbolic part of the conservation equations along with an appropriate treatment of the viscous terms. The TVD approach helps eliminate spurious numerical oscillations; the upwind scheme helps the numerical method to be faithful to the true signal propagation mechanisms. Along with the careful treatment of all viscous terms (including the cross-derivative terms), this approach results in a very robust methodology for solving a wide range of problems across the entire Mach number range from subsonic through hypersonic speeds. The Navier-Stokes equations, the Euler equations subset, and trends in computational fluid dynamics algorithms are covered. ESA

**N89-17826#** Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France).
**COMPRESSIBLE FLOW SOLVERS USING UNSTRUCTURED GRIDS** **c02**
J. A. Desideri and A. Dervieux *In* VKI, Computational Fluid Dynamics, Volume 2 1988 115 p (For primary document see N89-17824 10-34)
Avail: NTIS HC A17/MF A01

Spatial upwind approximation schemes, implicit unfactored delta schemes, a multigrid finite element method, and mesh adaptation algorithms are presented. ESA

**N89-17827#** Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France).
**REAL GASES**
J. A. Desideri *In* VKI, Computational Fluid Dynamics, Volume 2 1988 47 p (For primary document see N89-17824 10-34)
Avail: NTIS HC A17/MF A01

Implementation of numerical procedures in simulations of the reactive flow in the shock layer between the shock and a typical

blunt body, such as a space shuttle during hypersonic reentry, is examined. Mach number plots and the temperature plots obtained for a freestream Mach number = 25, for perfect gas flow, equilibrium-chemistry flow, nonequilibrium flow, R = 3 cms, 18-reactions model, are presented. The following stand-off distances can be measured from the Mach number plots: D/R = 0.48, D/R = 0.28, and D/R = 0.30, where D is the domain exterior to the body, R is radius of curvature. These distances are numerically overestimated. For example, in the perfect gas case, theory predicts that D/R = 0.39. The exact reasons for this discrepancy remain an open question; the use of a first-order, hence dissipative, scheme over an insufficiently fine mesh certainly plays a role. Nevertheless, one can observe that chemistry reduces stand-off distance by 40 percent in this case. The temperature levels are also reduced by 40 percent, but the patterns are noticeably different in the equilibrium and nonequilibirum cases. In the latter case, the temperature peak immediately behind the shock falls abruptly to a lower stagnation temperature; the temperature along the body eventually evolves to a higher level. ESA

**N89-17828#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**AN IMPLICIT APPROXIMATE FACTORIZATION FINITE VOLUME TECHNIQUE WITH IMPROVED ACCURACY FOR THE COMPRESSIBLE NAVIER-STOKES EQUATIONS**
Mart Borsboom *In its* Computational Fluid Dynamics, Volume 2 1988 100 p (For primary document see N89-17824 10-34)
Avail: NTIS HC A17/MF A01

An optimal low-order conservative scheme on a three-times-three point computational molecule, which is almost free of numerical diffusion, even on highly distorted grids, while still relatively easy to program, was developed, especially for Navier-Stokes calculations. An implicit time-marching technique is used as an iterative solver for the discretized system of equations. The backward Euler scheme has the best convergence properties. An analytical expression for the optimal time step was derived and applied everywhere on the domain (local time stepping) leading to optimal convergence properties of the scheme. Excellent results are obtained with the calculation at moderately high Reynolds number of a steady subsonic viscous flow over a backward facing step and through a cascade of NACA 0012 profiles. The method was extended for the efficient numerical simulation of unsteady flow. ESA

**N89-17829#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**A FULLY IMPLICIT SCHEME FOR UNSTEADY FLOW CALCULATIONS SOLVED BY THE APPROXIMATE FACTORIZATION TECHNIQUE**
M. Kloker and Mart Borsboom *In its* Computational Fluid Dynamics, Volume 2 1988 23 p (For primary document see N89-17824 10-34)
Avail: NTIS HC A17/MF A01

A fully implicit, second-order accurate scheme for unsteady flow calculations was developed. The large nonlinear system of algebraic equations is solved by the approximate factorization scheme by uncoupling the numerics from the physics via the introduction of a second time derivative. The stability limit on the time step is removed. Hence, it is possible to minimize the computational effort for solving unsteady flow problems by optimizing the convergence speed of the scheme. The method is especially advantageous in cases where the time step imposed by the numerics is much smaller than the time step that is required to resolve the physical unsteadiness of the flow problem. The scheme was implemented in an existing 2-D Navier-Stokes solver. Calculation of the two-dimensional unsteady laminar flow behind a cascade of circular cylinders confirms the capability of the scheme. Computational time is distinctly less than with the classical scheme. An astonishingly fast convergence is observed, which suggests applying a similar method to steady state calculations. ESA

**N89-17830*#** Flow Research, Inc., Kent, WA.
**FEASIBILITY OF GENERATING AN ARTIFICIAL BURST IN A TURBULENT BOUNDARY LAYER, PHASE 2 Final Technical Report, 12 May 1986 - 30 Oct. 1988**
Mohamed Gad-el-Hak Washington, DC Mar. 1989 132 p (Contract NAS1-18292)
(NASA-CR-4221; NAS 1.26:4221; Flow-TR-462) Avail: NTIS HC A07/MF A01 CSCL 20D

Various drag accounts for about half of the total drag on commercial aircraft at subsonic cruise conditions. Two avenues are available to achieve drag reduction: either laminar flow control or turbulence manipulation. The present research deals with the latter approach. The primary objective of Phase 2 research was to investigate experimentally the feasibility of substantially reducing the skin-friction drag in a turbulent boundary layer. The method combines the beneficial effects of suction and a longitudinally ribbed surface. At a sufficiently large spanwise separation, the streamwise grooves act as a nucleation site causing a focusing of low-speed streaks over the peaks. Suction is then applied intermittently through longitudinal slots located at selected locations along those peaks to obliterate the low-speed regions and to prevent bursting. Phase 2 research was divided into two tasks. In the first, selective suction from a single streamwise slot was used to eliminate either a single burst-like event or a periodic train of artificially generated bursts in laminar and turbulent boundary layers that develop on a flat plate towed in a water channel. The results indicate that equivalent values of the suction coefficient as low as 0.0006 were sufficient to eliminate the artificially generated bursts in a laminar boundary layer. Author

**N89-17831#** Japan Atomic Energy Research Inst., Tokyo.
**NUMERICAL PROGRAMS OF HEAT CONDUCTION PROBLEM USING A PERSONAL COMPUTER. COMPARISON OF VARIOUS NUMERICAL SCHEMES**
Tomoaki Kunugi Aug. 1988 49 p In JAPANESE; ENGLISH summary
(DE88-755522; JAERI-M-88-145) Avail: NTIS (US Sales Only) HC A03/MF A01

This paper describes the numerical procedures of steady and unsteady heat conduction problems using a personal computer. In this paper, eight numerical schemes for the one-dimensional unsteady heat conduction equation are discussed, and their results are compared with the analytical solutions. Consequently, it is found that the multipoint Adams-Bashforth method is the best scheme. Moreover, two-dimensional steady and unsteady heat conduction problems are solved by various numerical schemes, and their computational time and results are compared with each other. Thirteen numerical analysis programs and a subroutine to draw contour lines for their results are written by the BASIC language and all programs are listed in this paper. DOE

**N89-17832#** Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID.
**HEAT-OF-REACTION CHEMICAL HEAT PUMPS**
Lance Kirol and Carl Bliem Apr. 1988 120 p
(Contract DE-AC07-76ID-01570)
(DE89-004840; EGG-EP-7791) Avail: NTIS HC A06/MF A01

Chemical heat pumps are mechanically driven heat pumps with working fluids that undergo chemical changes or are heat-driven heat pumps in which either the driver (heat engine) or heat pump utilizes a reactive working fluid. As such, chemical heat pumps can be classified by drive (electric drive, heat amplifier, or temperature amplifier), operating mode (periodic or continuous), coupling between the heat engine and heat pumps, thermodynamic cycle used in the heat engine and heat pump, and phases of the working material. This classification of chemical heat pumps suggests many new heat pump configurations that have not been considered previously. This document describes possible heat pump configurations and the justification for selecting certain heat pumps for further study. Four types of heat-of-reaction chemical heat pumps are considered worthy of further development; the characteristics of these pumps are discussed in this document. DOE

**N89-17833#** Technische Hochschule, Aachen (Germany, F.R.). Mathematisch-Naturwissenschaftlichen Fakultaet.
**A BICHARACTERISTICS METHOD FOR THE CALCULATION OF COMPRESSION FOCUSING IN COMPRESSIBLE FLUIDS Ph.D. Thesis [EIN BICHARAKTERISTIKENVERFAHREN ZUR BERECHNUNG DER DRUCKWELLENFOKUSSIERUNG IN KOMPRESSIBLEN FLUIDEN]**
Jingqiu Chen 1987 77 p In GERMAN
(ETN-89-93494) Avail: NTIS HC A05/MF A01

The focusing of shock waves in fluids was numerically simulated using the bicharacteristics method of second order for plane or axisymmetric, unsteady flow of an ideal, friction and head conduction free gas. In spite of the curved boundaries and the large gradients in the neighborhood of the focus, the method shows good numerical stability in practical applications. The results of calculations for gases are qualitatively and quantitatively good. A substantially finer grid for the calculation of shock focusing in water is required to obtain a comparable accuracy. The numerical resolution is however not sufficient for calculation of the pressure peak. A combination of the bicharacteristics method and the Whitham method is proposed to reduce the number of grid calculation points and to calculate the experimentally observed high pressure amplitudes. ESA

**N89-17834#** Eidgenoessisches Flugzeugwerk, Emmen (Switzerland). Aerodynamic und Flugmechanik.
**DETERMINATION OF THE CRITICAL ROUGHNESS HEIGHT FOR PLANE AND AXISYMMETRIC BOUNDARY LAYERS**
Felix Hirt 24 Nov. 1987 44 p In GERMAN; ENGLISH summary
(F+W-TF-1797; ETN-89-93537) Avail: NTIS HC A03/MF A01

A general method for the estimation of the critical roughness height was developed using a boundary layer calculation. The method was applied to OMEGA-C5 wind tunnel calibration models. It is found that the critical roughness height lies within the range of the boundary layer momentum thickness height at the positioning location. The increase of aerodynamic drag due to single roughness devices increases with the third power of its roughness height. In order to get the same drag increase on geometrically similar C5 calibration bodies, the height of roughness in the considered transition region has to be the same on all bodies. ESA

**N89-17835#** Laboratoire d'Informatique pour la Mecanique et les Sciences de l'Ingenieur, Paris (France).
**SOLUTION OF THE EULER AND NAVIER-STOKES EQUATIONS BY A COMBINATION METHOD Final Report [RESOLUTION DES EQUATIONS D'EULER ET DE NAVIER-STOKES PAR UNE METHODE COMBINEE]**
A. Jolles and S. Huberson 11 Oct. 1988 58 p In FRENCH
(Contract DRET-85-1418/DS/SR)
(ETN-89-94095) Avail: NTIS HC A04/MF A01

A computing method for flows presenting zones with high vortex concentration is presented. The method is a variant of the cloud and cell method, which allows an approach both Lagrangian and Eulerian, while the computation time is relatively low for the large number of points treated. A finite difference method is used to solve the equations. The resulting computer program allows a good representation of high gradient regions though keeping an economical treatment for zones of low perturbation. ESA

**N89-17836#** Institut National des Sciences Appliquees, Lyon (France). Lab. de Mecanique des Fluides et Thermique.
**EFFECT OF ELASTIC OR VISCOELASTIC DUCT ANCHORAGE ON UNSTEADY FLUID FLOWS Ph.D. Thesis**
Abdelouaheb Djemili 1988 109 p In FRENCH; ENGLISH summary
(IDI1-8805; ETN-89-94099) Avail: NTIS HC A06/MF A01

Techniques based on viscoelastic modeling or iterative treatment of fluid flow and duct deformation were developed. The equations are obtained and solved either by the Hartree finite difference method with interpolation over space or time, or the Laplace-Carson transforms. Comparison of the two techniques shows that the treatment of the whole problem through the general equations governing the fluid flow and the wall displacement is superior to the other method. For the resolution mode, the use of the Laplace-Carson transform is found possible only for simple cases. ESA

**N89-17837#** Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.
**TRANSPORT COEFFICIENTS IN DIRECT SIMULATION MONTE CARLO METHOD FOR RAREFIED GAS FLOW**
Takashi Abe Jul. 1988 6 p
(ISAS-631; ISSN-0285-6808) Avail: NTIS HC A02/MF A01

A method to obtain transport coefficients for systems simulated by the direct simulation Monte Carlo Method is proposed using the fluctuation-dissipation theorem. Its application is demonstrated by determining the viscosity coefficient. To this end, the correlation function was calculated numerically in the equilibrium system modeled by the direct simulation Monte Carlo method. The viscosity coefficient was obtained by matching, in the collisional regime, the numerical correlation function with the theoretical one, the viscosity coefficient being a free parameter. The viscosity so determined agrees well with the one given by the Chapman-Enskog method. The present method can also be used to obtain the other transport coefficients in much more complex, multispecies gases. Author

**N89-17838#** International Centre for Theoretical Physics, Trieste (Italy).
**LOWER LIMIT OF STATIONARY SHOCK STRENGTH IN ADIABATIC FLOWS**
Sandip K. Chakrabarti Jul. 1988 9 p
(DE88-704710; IC-88/152) Avail: NTIS (US Sales Only) HC A02/MF A01

We show that there is a lower limit of the shock strength Sigma = M(sub -)/M(sub +), where M(sub -) and M(sub +) are the Mach numbers before and after the shock, for adiabatic flows in vertical equilibrium. The limit is independent of the nature of the force field governing the flow or the mass flux and only depends upon the adiabatic index. DOE

**N89-17839#** International Centre for Theoretical Physics, Trieste (Italy).
**EQUILIBRIUM CONFIGURATION FOR AN INERTIALLY DRAGGED VISCOUS FLUID AROUND A SLOWLY ROTATING COMPACT OBJECT**
A. R. Prasanna Aug. 1988 19 p
(DE88-704741; IC-88/216) Avail: NTIS (US Sales Only) HC A03/MF A01

It is shown that physically meaningful fluid distributions in the form of a thin disk around a rotating compact object can exist in equilibrium where the angular velocity of the fluid is entirely due to the dragging induced by the space-time surrounding the compact object. The pressure balance at the inner edge is mainly due to the equality of the radiation pressure and the hydrostatic gas pressure. If there is no bulk viscosity the pressure remains constant throughout the disk whereas with increasing bulk viscosity the pressure drops in the inner regions but soon stabilizes at an almost constant value. DOE

**N89-17840#** Los Alamos National Lab., NM.
**STATISTICAL THEORIES OF RAYLEIGH-TAYLOR INSTABILITY FOR COMPRESSIBLE FLUIDS**
J. Glimm, X. L. Li, Q. Zhang, R. Menikoff, and D. H. Sharp 1988 10 p Presented at the Workshop on the Physics of Compressible Turbulent Mixing, Princeton, NJ, 24 Oct. 1988 Prepared in cooperation with New York Univ., New York.
(Contract W-7405-eng-36)
(DE89-003472; LA-UR-88-3702; CONF-8810234-1) Avail: NTIS HC A02/MF A01

Statistical theories for the outer envelope of the Rayleigh-Taylor mixing layer refer to a simplified dynamics of fundamental modes and their interactions. These modes are bubbles of light fluid entrained in the mixing layer between the undisturbed light and heavy fluids. The dynamics can be understood in terms of the

motion of a single mode and the interactions between modes. The single mode dynamics has to be solved self-consistently in a background field of random bubbles. The dominant interaction is bubble merger, i.e., the spreading of larger bubbles at the bubble envelope. Merger leads to dynamically increasing length scales, and thus to a dynamic renormalization of scaling dimensions. The mechanism for bubble merger is the differential motion of physically adjacent single bubble modes. This paper is focused on the above topics: single bubble motion, bubble interactions and statistical models. DOE

**N89-17841#** Naval Research Lab., Washington, DC. Lab. for Computational Physics and Fluid Dynamics.
**UNSTABLE WAVES OF JET FLOWS WITH DENSITY INHOMOGENEITY Interim Report, Aug. 1987 - Apr. 1988**
Yee T. Fung 23 Sep. 1988 17 p
(RR0230141)
(AD-A200618; NRL-MR-6271) Avail: NTIS HC A03/MF A01 CSCL 20D

The problem to be considered concerns linear unstable waves of axisymmetric jet flows in the presence of density inhomogeneities. Such flow phenomena occur when a jet is discharged into a stratified medium, e.g., pollutants and industrial waste discharged into the environment, cooling water discharged from power plants into rivers and lakes, and flow patterns generated by vehicles moving in the ocean. Investigating the instability characteristics of the flow can mean controlling the flow-patterns, for example, produced by vehicles moving in the ocean. As in the case of two-dimensional shear flows, axisymmetric jet flows may possess amplified waves due to the Kelvin-Helmhholtz mechanism except that the formulation for jet flows is complicated by the absence of the Squire transformation and the consideration of cylindrical geometry. GRA

**N89-17842#** Naval Postgraduate School, Monterey, CA.
**A STUDY OF NATURAL CONVECTION COOLING OF MULTIPLE DISCRETE HEAT SOURCES IN A VERTICAL CHANNEL M.S. Thesis**
Thomas D. Willson Jun. 1988 147 p
(AD-A200947) Avail: NTIS HC A07/MF A01 CSCL 20M

Natural convection liquid cooling of simulated electronic components in a vertical channel was investigated. The test surface contained a single column of eight rectangular, protruding heated elements, each simulating a 20 pin dual-in-line package. Temperature measurements and flow visualization were performed for a number of power dissipation levels and channel widths. Collectively, this information was used in interpreting the flow and transport characteristics. A correlation to predict the heat transfer rates was developed based on the component surface temperatures. Optimum channel widths were determined from these surface temperature measurements for the range of power levels investigated. Temperature distributions in the fluid were measured using a traversing thermocouple probe. GRA

**N89-17843#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH.
**IMPLICIT ALGORITHM FOR NUMERICAL SOLUTION OF THE LAMINAR INCOMPRESSIBLE TWO-DIMENSIONAL NAVIER-STOKES EQUATIONS Final Report, Nov. 1985 - May 1987**
D. P. Rizzetta May 1988 51 p
(AD-A201075; AFWAL-TR-87-3051) Avail: NTIS HC A04/MF A01 CSCL 20D

A numerical procedure is presented for solution of the laminar incompressible two dimensional Navier Stokes equations written in terms of the stream function and vorticity. The full implicit unified method is capable of treating both steady and unsteady flows. The governing equations are solved in conservation form, incorporating a general transformation of the independent variables so that arbitrary geometrical configurations may be considered. In the steady case, the algorithm corresponds identically to Newton's method as applied to the solution of nonlinear partial differential equations. For unsteady flows, the procedure is second order accurate temporally as well as spatially. An analysis of a model system of equations is provided which indicates numerical stability. Utility of the method is verified by calculation of representative examples of both steady and unsteady flow fields. These include the classic driven cavity problem and the unsteady flow about a circular cylinder. Results of these computations are compared with previous numerical solutions as well as with experimental data. GRA

**N89-17844#** Naval Underwater Systems Center, New London, CT.
**TURBULENT BOUNDARY LAYER ON A CYLINDER IN AXIAL FLOW**
Richard M. Lueptow 29 Sep. 1988 66 p
(AD-A201102; NUSC-TR-8389) Avail: NTIS HC A04/MF A01 CSCL 20D

This report reviews research on the turbulent boundary layer that develops on a cylinder in axial flow. Experimental results indicate that the transverse curvature results in a higher coefficient of friction and a fuller velocity profile than for a planar boundary layer. However, appropriate scaling laws and nondimensional scaling parameters are still elusive. The few turbulence measurements such as Reynolds stress and intermittency that are available for a cylindrical boundary layer suggest that the distribution of turbulent quantities in the boundary layer is somewhat different from a planar boundary layer, particularly as the boundary layer becomes thick compared to the radius of the cylinder. This is most likely a result of the tendency for a cylindrical boundary layer to become wake-like as the cylinder becomes very small. Measurements of turbulence intensity and detection of turbulence-generating events in a cylindrical boundary layer suggest that the mechanism for the production of turbulence near the wall is similar to that for other wall-bounded flows. However, there is experimental evidence that the outer flow interacts with the near-wall flow to modify the generation of turbulence. Suggestions for further work include more comprehensive and sophisticated measurements of turbulent quantities in cylindrical boundary layers as well as computational modeling. GRA

**N89-17845#** Los Alamos National Lab., NM.
**EXPERIMENTAL OBSERVATIONS OF SHOCK STABILITY AND SHOCK-INDUCED TURBULENCE**
Robert F. Benjamin 1988 13 p Presented at the Workshop on the Physics of Compressible Turbulent Mixing, Princeton, NJ, 24 Oct. 1988
(Contract W-7405-eng-36)
(DE89-005473; LA-UR-88-4229; CONF-8810234-4) Avail: NTIS HC A03/MF A01

We observe the Richtmyer-Meshkov (RM) instability of a perturbed, shock-accelerated interface between different gases. Instability growth of a singly shocked interface is observed to be consistent with previous experimental data. Late-time growth visually appears nonlinear but the growth rate remains the same as during linear growth. Re-shocking the interface produces additional RM growth and substantial profile broadening, which does not show the effect of local vorticity generation. DOE

**N89-17846#** Los Alamos National Lab., NM.
**OPTICAL MAGNIFICATION CORRECTION IN DYNAMIC SIZE MEASUREMENTS FROM REFRACTION AT CONICAL SHOCK FRONTS**
D. R. Goosman 19 Oct. 1988 11 p
(Contract W-7405-eng-48)
(DE89-004973; UCRL-53872-Rev-1) Avail: NTIS HC A03/MF A01

An analytical formula is derived for the magnification error in optical size measurements of objects inside conically shaped shock fronts. End detonation of a cylindrically shaped explosive immersed in a fluid necessitates a correction due to refraction at the interface between the shocked and unshocked fluids. It is shown that for detonations immersed in a liquid such as water, the correction factor derived for a conical shock front is significantly larger than

the simple correction factor derived if the shock front is assumed to be cylindrical. DOE

# 35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing.* For related information see also *06 Aircraft Instrumentation,* and *19 Spacecraft Instrumentation.*

**N89-17847#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Physik.

**DESIGN, CONSTRUCTION, AND TESTING OF A CORRECTED ELECTRON ENERGY LOSS SPECTROMETER WITH HIGH DISPERSION AND LARGE ACCEPTANCE ANGLE Ph.D. Thesis [ENTWURF, BAU UND ERPROBUNG EINES KORRIGIERTEN ELEKTRONEN- ENERGIEVERLUST- SPEKTROMETERS MIT GROSSER DISPERSION UND GROSSEM AKZEPTANZWINKEL]**

Maximilian Haider 1986 129 p In GERMAN
(ETN-89-93498) Avail: NTIS HC A07/MF A01

An electron energy loss spectrometer was developed and built, and tested with respect to its electron-optics properties, to obtain information concerning the chemical composition of biological objects. It is shown that with conventional spectrometers the two main objects cannot be achieved, namely parallel detection of the spectrum together with a good energy resolution and a large acceptance angle. Parallel detection is obtained by increasing the dispersion of the spectrometer using a symmetric system with two deviation prisms. The large acceptance angle is obtained by a correction of the opening error of the spectrometer. A computer program was developed for the calculation of the electron-optics characteristics. Experiments show that the requirements for dispersion and acceptance angle are fulfilled, thereby providing the electron-optics basis for fine analysis of biological objects as well as for novel imaging methods in scanning transmission electron microscopy. ESA

**N89-17848#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Physik.

**CONSTRUCTION OF A HIGH PRESSURE APPARATUS FOR ELECTRON SPIN RESONANCE MEASUREMENTS AT LOW TEMPERATURES, AND APPLICATION TO THE FERROELECTRIC CRYSTAL BaTiO3 Ph.D. Thesis [KONSTRUKTION EINER HOCHDRUCKAPPARATUR FUER ELEKTRONEN-SPIN-RESONANZ-MESSUNGEN BEI TIEFEN TEMPERATUREN UND ANWENDUNG AUF DEN FERROELEKTRISCHEN KRISTALL BATIO3]**

Norbert Preusse 1987 112 p In GERMAN
(ETN-89-93504) Avail: NTIS HC A06/MF A01

An electron spin resonance (ESR) high pressure apparatus was developed, which significantly exceeds the pressure range of the piston-cylinder apparatus, and whose principle allows to reach pressures as high as 50 kbar. The construction and the essential properties of the pressure apparatus are described. The versatility of the ESR pressure apparatus was demonstrated on BaTiO3; it substantially extends the measuring range of ESR. Proposals for investigations using the developed high-pressure technique are given. ESA

**N89-17849#** California Univ., Berkeley. Lawrence Berkeley Lab. Accelerator and Fusion Research Div.

**X-RAY HOLOGRAPHIC MICROSCOPY: IMPROVED IMAGES OF ZYMOGEN GRANULES**

Chris Jacobsen, Malcolm Howells, James Kirz, Kenneth McQuaid, and Stephen Rothman (California Univ., San Francisco.) Oct. 1988 11 p Presented at the 4th Topical Meeting on Short Wavelength Coherent Radiation: Generation and Applications, Cape Code, MA, 26 Sep. 1988
(Contracts DE-AC03-76SF-00098; DE-AC02-76CH-00016)
(DE89-004783; LBL-26187; CONF-880904-6) Avail: NTIS HC A03/MF A01

Soft X-ray holography has long been considered as a technique for X-ray microscopy. It has been only recently, however, that sub-micron resolution has been obtained in X-ray holography. This paper will concentrate on recent progress we have made in obtaining reconstructed images of improved quality. DOE

**N89-17850#** Washington Univ., Seattle. Dept. of Materials Science and Engineering.

**ACQUISITION OF A HIGH VOLTAGE/HIGH RESOLUTION TRANSMISSION ELECTRON MICROSCOPE Final Report, 1 Jan. 1987 - 31 Dec. 1987**

Ilhan A. Aksay and Mehmet Sarikaya 21 Aug. 1988 67 p
(Grant AF-AFOSR-0078-87; AF Proj. 2917)
(AD-A200794; AFOSR-88-1015TR) Avail: NTIS HC A04/MF A01 CSCL 14B

This report describes the status of a transmission electron microscopy system that was purchased through a grant entitled Request for a High Voltage/High Resolution Scanning Transmission Electron Microscope. The microscope purchased is Philips EM 430T; accessories bought with the microscope are an energy-dispersive X-ray spectrometer (EDS) and an electron energy loss spectrometer (EELS). The tests at all modes of analysis have been completed and the results indicate that the instrument and its peripherals operate at their expected performance. The system has already proven to be an indispensable tool in projects on the development of advanced materials and it is expected that it will serve as a primary characterization tool in future projects. GRA

**N89-17851#** Lightwave Electronics Corp., Mountain View, CA.

**INTERFEROMETRIC HIGH-PRESSURE SENSOR Final Contract Report, 3 Aug. 1987 - 3 Feb. 1988**

Emily A. Cheng, William M. Grossman, and Richard W. Wallace Dec. 1988 37 p
(Contract DAAA15-87-C-0057)
(AD-A200952; BRL-CR-603) Avail: NTIS HC A03/MF A01 CSCL 14B

This work proved the feasibility of an interferometric, high pressure sensor. A pressure measurement system based on a birefringent, compact, Fabry-Perot etalon was selected and designed. The temperature response of the reflectivity of the etalon was calibrated; a 1 C change in temperature was equivalent to a 1000 psi pressure change. Efficient coupling of the key components was demonstrated using a monolithic, single-frequency, diode-pumped ring laser (developed at Lightwave Electronics Corp. based on Stanford University research), a single-mode optical fiber, and a sapphire etalon. Successful experimental results demonstrated that an optical pressure transducer can be made that has the properties of compactness, wide pressure range, immunity to electro-magnetic interference, and low cost. GRA

**N89-17852#** Florida Univ., Gainesville. Dept. of Mechanical Engineering.

**FACTORS AFFECTING THE ACCURACY OF THE INTEGRATED PARTICLE SIZING SYSTEM Final Report, May 1983 - Oct. 1985**

Charles L. Proctor, Barbara D. Isager, and Abderrahama Touati Aug. 1988 82 p
(AD-A201131; AFESC/ESL-TR-86-49) Avail: NTIS HC A05/MF A01 CSCL 21E

The purpose of this research was to investigate factors affecting instrument accuracy of a nonintrusive optical system known as the Integrated Particle Sizing System (IPSS). Studies of soot formation and growth in laboratory combustors were conducted at the Air Force Engineering and Services Center, Environics Division, using the IPSS. However, the behavior of this instrument and the factors affecting its accuracy were not completely understood, causing the proper operation of the instrument and the interpretation of results to be questioned. This report focused on the theory governing the instrument's design. A list of limitations

imposed by theory was derived and measurements were made to verify the relationship between incoming signal, theory, and actual particle size. GRA

**N89-17853#** Los Alamos National Lab., NM.
**RECENT ADVANCES IN HIGH SPEED PHOTOGRAPHY AND ASSOCIATED TECHNOLOGIES IN THE USA**
Dennis Lee Paisley 1988 10 p Presented at the 18th International Congress on High-speed Photography and Photonics, Xian, China, 28 Aug. - 2 Sep. 1988
(Contract W-7405-eng-36)
(DE89-005460; LA-UR-88-4131; CONF-8808103-5) Avail: NTIS HC A02/MF A01

In the past decade, high speed photography has been rapidly incorporating electro-optics. More recently, optoelectronics and digital recording of images for specialized laboratory cameras and commercially available systems have helped broaden the versatility and applications of high speed photography and photonics. This paper will highlight some of these technologies and specialized systems. DOE

**N89-17608#** Litton Technische Werke, Freiburg (Germany, F.R.).
**PACKAGED FIBER OPTIC GYROS**
H.-J. Bueschelberger and W. Schroeder *In* AGARD, Guidance and Control of Precision Guided Weapons Nov. 1988 7 p (For primary document see N89-17605 10-15)
Copyright Avail: NTIS HC A05/MF A01

**N89-18321*#** European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands). Dept. of Space Science.
**AN INSTRUMENT FOR MEASURING THE COMPLEX PERMITTIVITY OF THE MARTIAN TOP SOIL**
R. Grard *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 90-91 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 14B

**N89-18369*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**IN SITU XRF AND GAMMA RAY SPECTROMETER FOR MARS SAMPLE RETURN MISSION**
I. Yin Lo, Jacob I. Trombka, Larry G. Evans, and Steven W. Squyres (Cornell Univ., Ithaca, NY.) *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 182-183 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 14B

**N89-18406*#** National Aeronautics and Space Administration, Washington, DC.
**SENSOR TECHNOLOGY**
Martin M. Sokoloski *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 203-223 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 14B

## 36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

**N89-17854#** Lawrence Livermore National Lab., CA.
**X-RAY CONVERSION PHYSICS**
R. L. Kauffman, D. R. Kania, S. Langer, H. Kornblum, and F. Ze Oct. 1988 3 p Presented at the 19th European Conference on Laser Interaction with Matter (ECLIM), Madrid, Spain, 3-7 Oct. 1988
(Contract W-7405-eng-48)
(DE89-002899; UCRL-99700; CONF-881056-8) Avail: NTIS HC A02/MF A01

We have performed a series of experiments to study the physics of the conversion of 0.35 micron laser light to soft X-rays in high-Z materials. The efficiency of soft X-ray and M-band radiation production as a function of laser intensity (5 times 10 to the 13th power to 3 times 10 to the 15 power W/cm²) was measured. At fixed intensity 5 times 10 to the 14th power W/cm², the time-resolved and time-integrated thermal X-ray (E less than 1.5 keV) conversion efficiency increased with the laser pulse length for up to 4-ns-long pulses on gold targets. The effects of material opacity were examined by making targets of mixtures of gold and beryllium to vary the density of the strongly radiating gold in the target. These experiments demonstrate the effects of material opacity on both thermal and M-band X-ray production. These experiments were performed with large laser spots and greater than 1 kj of 0.35 micron laser light using the Nova laser. These experiments have expanded our understanding of our ability to computer model the interaction of high intensity laser light with high-Z plasmas. DOE

**N89-17855*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**ANALYSIS OF Nd3+:GLASS, SOLAR-PUMPED, HIGH-POWER LASER SYSTEMS**
L. E. Zapata and M. D. Williams Feb. 1989 13 p
(NASA-TP-2905; L-16085; NAS 1.60:2905) Avail: NTIS HC A03/MF A01 CSCL 20E

The operating characteristics of Nd(3+):glass lasers energized by a solar concentrator were analyzed for the hosts YAG, silicate glass, and phosphate glass. The modeling is based on the slab zigzag laser geometry and assumes that chemical hardening methods for glass are successful in increasing glass hardness by a factor of 4. On this basis, it was found that a realistic 1-MW solar-pumped laser might be constructed from phosphate glass 4 sq m in area and 2 mm thick. If YAG were the host medium, a 1-MW solar-pumped laser need only be 0.5 sq m in area and 0.5 cm thick, which is already possible. In addition, Nd(3+) doped glass fibers were found to be excellent solar-pumped laser candidates. The small diameter of fibers eliminates thermal stress problems, and if their diameter is kept small (10 microns), they propagate a Gaussian single mode which can be expanded and transmitted long distances in space. Fiber lasers could then be used for communications in space or could be bundled and the individual beams summed or phase-matched for high-power operation. Author

**N89-17856*#** California Univ., San Diego, La Jolla. Dept. of Chemical Engineering.
**DESIGN OF CATALYTIC MONOLITHS FOR CLOSED-CYCLE CARBON DIOXIDE LASERS Final Report**
R. K. Herz, K. Guinn, S. Goldblum, and E. Noskowski 24 Feb. 1989 65 p
(Grant NAG1-823)
(NASA-CR-184790; NAS 1.26:184790) Avail: NTIS HC A04/MF A01 CSCL 20E

Pulsed carbon dioxide (CO2) lasers have many applications in aeronautics, space research, weather monitoring and other areas. Full exploitation of the potential of these lasers in hampered by the dissociation of CO2 that occurs during laser operation. The development of closed-cycle CO2 lasers requires active CO-O2 recombination (CO oxidation) catalyst and design methods for implementation of catalysts in CO2 laser systems. A monolith catalyst section model and associated design computer program, LASCAT, are presented to assist in the design of a monolith catalyst section of a closed cycle CO2 laser system. Using LASCAT,the designer is able to specify a number of system parameters and determine the monolith section performance. Trade-offs between the catalyst activity, catalyst dimensions, monolith dimensions, pressure drop, O2 conversion, and other variables can be explored and adjusted to meet system design specifications. An introduction describes a typical closed-cycle CO2 system, and indicates some advantages of a closed cycle laser system over an open cycle system and some advantages of monolith support over other types of supports. The development and use of a monolith catalyst model is presented. The results of a design study and a discussion of general design rules are given. Author

**N89-17857#** Los Alamos National Lab., NM. Environmental Sciences Div.
**THE DEVELOPMENT AND APPLICATION OF A SHORT RANGE, REAL-TIME ACTIVE IMAGING SYSTEM**
Thomas J. Kulp, Randall Kennedy, Darrel Garvis, and Thomas G. McRae (Laser Imaging Systems, Inc., Punta Gorda, FL.) Nov. 1988 14 p Presented at the Conference Session on Thermal and Infrared Sensing, Santa Ana, CA, 30 Oct. 1988
(Contract W-7405-eng-48)
(DE89-004020; UCRL-99408; CONF-8810267-1) Avail: NTIS HC A03/MF A01

A laser active-imaging system capable of producing real-time, standard (RS-170) TV images was developed. The system consists of a modified flying-spot infrared imager that scans the instantaneous-field-of-view of a single detector in synchrony with the output beam of a continuous-wave laser. The imager has been modified for application to the problems of gas-plume imaging and underwater imaging. DOE

**N89-17858#** Oak Ridge National Lab., TN.
**DYNAMICS OF COUPLED SINGLE PARTICLE ELECTRON AND COLLECTIVE NUCLEAR MOTION IN A LASER FIELD**
F. X. Hartmann, D. W. Noid, and Y. Y. Sharon (Princeton Univ., NJ.) 1988 6 p Presented at the 35th National Vacuum Symposium and 4th International Laser Science Conference, Atlanta, GA, 2 Oct. 1988
(Contract DE-AC05-84OR-21400)
(DE89-005121; CONF-881002-4) Avail: NTIS HC A02/MF A01

A simple model of coupled electronic and collective nuclear motion is used to study energy transfer processes in the presence of a laser field. The complete classical Hamiltonian of the model includes nuclear, electronic and laser field terms. A semi-classical method to extract spectral information from the generated trajectories is used to calculate transition intensities and frequencies for the coupled quantum mechanical transitions. The nuclear term describes a deformed heavy nucleus with potential well parameters based on the recent work by Sharon and Naumann, it sufficiently treats collective nuclear rotational motion lower in frequency than in the single particle nucleon model. We reported on the dynamics of this model in the presence of a laser field; a problem of interest in laser-driven nuclear excitation. DOE

**N89-17859#** Technische Univ., Berlin (Germany, F.R.). Fachbereich Physik.
**PHASE CONJUGATION OF Nd:YAG LASER RADIATION Ph.D. Thesis [PHASENKONJUGATION VON ND:YAG LASERSTRAHLUNG]**
Jun Chen 1988 129 p In GERMAN Sponsored by Deutsche Forchungsgemeinschaft, Bonn, Fed. Republic of Germany and Zheijing Univ., China Original contains color illustrations
(ETN-89-93484) Avail: NTIS HC A07/MF A01

The phase conjugation of Nd:YAG laser radiation by four-wave mixing in silicon and by stimulated Brillouin scattering in acetone and other organic liquids was experimentally and theoretically investigated. Due to nonlinear absorption in Si a saturation of the reflection of the phase conjugator was theoretically predicted, and experimentally observed. It is theoretically and experimentally shown that the radiation profile behind the Si-sample is annular due to defocusing. The experiments show that CS2 and acetone have the lowest thresholds for stimulated Brillouin scattering. A laser resonator was built using a Brillouin cell and two normal mirrors; the emitted laser beam is insensitive to phase perturbations in the resonator, and has a pulse duration of 5 ns and a pulse energy of 220 m. ESA

**N89-17860** Technische Univ., Hanover (Germany, F.R.). Fachbereich Physik.
**VERIFICATION OF A SIMPLE MODEL OF A XeCl EXCITED STATE LASER DISCHARGE BY THE MEASUREMENT OF CURRENT, VOLTAGE AND LASER EMISSION Ph.D. Thesis [VERIFIKATION EINES EINFACHEN MODELLS EINER XECL EXCITED-LASERENTLADUNG DURCH MESSUNG VON STROM, SPANNUNG UND LASEREMISSION]**
Gotthard Stielow 1987 163 p In GERMAN
(ETN-89-93489) Avail: Universitaet Hannover, Welfengarten 1, D-3000 Hannover 1, Federal Republic of Germany

On a xenon chloride laser (type EMG50) current and voltage, as well as laser power and energy were measured in a range of gas compositions and currents, in order to adapt the numerical code EXCKIM to the investigated laser. The code comprises the integration of the interacting system consisting of electric circuit, resonator, and reaction kinetics, as well as the solution of the Boltzmann equation. The error analyses and the interpretation of the experimental results using the EXCKIM model predictions show that the electric circuit of the EMG50 can be correctly modelled, that the resonator model is not satisfactory, and that the measured discharge voltage cannot be used to check the reaction kinetics. The development of a code that allows scaling and explanation of discharge instabilities, requires the careful determination of electric circuit and reaction kinetics on the basis of redundant experimental data. ESA

**N89-17861** Technische Univ., Hanover (Germany, F.R.). Fachbereich Physik.
**INVESTIGATIONS OF THE REACTION KINETICS OF GAS-DISCHARGE-PUMPED XeCl EXCITED STATE LASERS USING HIGHLY TIME-RESOLVED ABSORPTION-SPECTROSCOPICAL MEASUREMENTS OF Xe EXCITED STATE PARTICLE DENSITIES Ph.D. Thesis [UNTERSUNCHUNGEN ZUR REAKTIONSKINETIK GASENTLADUNGSGEPUMPTER XECL EXCITED-LASER MITTELS HOCHZEITAUFGELOESTER ABSORPTIONSSPEKTROSKOPISCHER MESSUNGEN VON XE 'EXCITED'-TEILCHENZAHLDICHTEN]**
Thomas Hammer 1987 178 p In GERMAN
(ETN-89-93490) Avail: Universitaet Hannover, Welfengarten 1, D-3000 Hannover 1, Federal Republic of Germany

An absorption experiment for the time-resolved particle density measurement of excited Xe atoms in an XeCl laser discharge is presented. The fundamentals of the absorption measurement, and the experimental setup are described. The measurements show that the induced emission is essential for the interpretation. The evolution of particle density can be followed, even far into the ignition phase of the discharge. The increase of effective particle densities was determined as a function of the discharge parameters. A reaction kinetic model was developed for the XeCl laser. It is found that the model results depend on the treatment of the HCl kinetics. The comparison of model and experiment shows that the vibrational excitation and the dissociative attachment are described by energy dependent cross sections instead of by rate constants. ESA

**N89-17862#** International Centre for Theoretical Physics, Trieste (Italy).
**SEMICONDUCTOR LASER SHEARING INTERFEROMETER**
Hai Ming, Ming Li, Nong Chen, and Jiaping Xie (China Scientific and Technical Univ., Hofei.) Mar. 1988 8 p
(DE88-704695; IC-88/68) Avail: NTIS (US Sales Only) HC A02/MF A01

The application of semiconductor laser on grating shearing interferometry is studied experimentally in the present paper. The method measuring the coherence of semiconductor laser beam by ion etching double frequency grating is proposed. The experimental result of lens aberration with semiconductor laser shearing interferometer is given. Talbot shearing interferometry of semiconductor laser is also described. DOE

**N89-17863#** Sandia National Labs., Albuquerque, NM.
**RADIATION EFFECTS IN HIGH POWER LASER DIODES: NEUTRONS**
R. F. Carson 1988 32 p Presented at the Military Fibre Optic Conference '88, Los Angeles, CA, 5 Dec. 1988
(Contract DE-AC04-76DP-00789)
(DE89-003403; SAND-88-2998C; CONF-881247-2) Avail: NTIS HC A03/MF A01

This presentation outline contains: high power laser diode

applications; environmental effects such as nuclear radiation; testing of high power laser diode arrays and broad area laser diodes for response to gamma irradiation, flash x-rays, and neutrons; and the results of neutron irradiation testing. DOE

**N89-17864#** Los Alamos National Lab., NM.
**EXCITATION OF LASING MEDIA USING ANTIPROTON-ANNIHILATION PRODUCTS**
Steven D. Howe and Michael V. Hynes 1988 11 p Presented at the LASERS '88, Lake Tahoe, NV, 5 Dec. 1988
(Contract W-7405-eng-36)
(DE89-003602; LA-UR-88-3983; CONF-881244-1) Avail: NTIS HC A03/MF A01

Lasing has been achieved in many different media using a wide variety of excitation mechanisms including low-energy electron or proton beams and recoiling fission products. In all cases, the power density produced in the medium has been the critical parameter. Recent calculations indicate that a region of high-power density can be achieved in high-density lasing media by allowing antiprotons to annihilate in the material with an intense magnetic field present. Because of the long range of energetic annihilation products, the media can be gaseous, liquid, or solid. The thermalization time is the critical parameter for this excitation mechanism which for liquid-density media, such as Ar-Xe mixtures, is about 2.1 ns. Based on these calculations power density of about 100 MW/cm³ can be achieved using a level of antiprotons that is currently available today. Development of an antiproton pumping source may allow fundamental reaction kinetics in a wide variety of lasing systems to be performed in a university environment. The results of the calculations in a liquid medium and at different magnetic field strength will be presented. In addition, the design of an ongoing experiment using an 800 MeV proton beam to pump a liquid density excimer cavity will be discussed. These preliminary experiments intend to focus on fundamental kinetics and on the effects of a strong magnetic field on reactions. DOE

**N89-17865#** Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Nuclear Physics.
**COMPUTATION OF EMITTANCE GROWTH IN A FOCUSING WIGGLER FEL (FREE ELECTRON LASER)**
I. Ben-Zvi and J. M. Wachtel 1988 11 p Presented at the 10th International Free-Electron Laser Conference, Jerusalem, Israel, 29 Aug. 1988 Prepared in cooperation with Brookhaven National Lab., Upton, NY.
(Contract DE-AC02-76CH-00016)
(DE89-004515; BNL-41920; CONF-8808146-11) Avail: NTIS HC A03/MF A01

Computed electron trajectories in a free electron laser show significant emittance growth in the wiggle plane when there are wiggler field gradients. For a low gain free electron laser using a focusing planar wiggler, phase space plots show the development of this 3-dimensional effect as well as rotation of the phase space region occupied by the beam due to betatron oscillations in the focusing wiggler field. Matching the input electron beam to the wiggler eliminates emittance growth. DOE

**N89-17866#** California Univ., Berkeley. Lawrence Berkeley Lab. Accelerator and Fusion Research Div.
**RF AND SPACE-CHARGE INDUCED EMITTANCES IN LASER-DRIVEN RF GUNS**
Kwang-Je Kim and Yu-Jiuan Chen Oct. 1988 3 p Presented at the Linear Accelerator Conference, Williamsburg, VA, 3 Oct. 1988
(Contract DE-AC03-76SF-00098)
(DE89-004693; LBL-26050; CONF-881049-48) Avail: NTIS HC A02/MF A01

Laser-driven RF electron guns are potential sources of high-current, low-emittance, short bunch-length electron beams, which are required for many advanced accelerator applications, such as free-electron lasers and injectors for high-energy machines. In such guns the design of which was pioneered at Los Alamos National Laboratory and which is currently being developed at several other laboratories, a high-power laser beam illuminates a photo-cathode surface placed on an end wall of an RF cavity. The main advantages of this type of gun are that the time structure of the electron beam is controlled by the laser, eliminating the need for bunchers, and that the electric field in RF cavities can be made very strong, so that the effects due to space-charge repulsion can be minimized. In this paper, we present an approximate but simple analysis for the transverse and longitudinal emittances in RF guns that takes into account both the time variation of the RF field and the space-charge effect. The results are compared and found to agree well with those from simulation. DOE

**N89-17867#** Stanford Univ., CA. Physics Lab.
**LASER PHYSICS AND LASER SPECTROSCOPY Final Technical Report, 1 Mar. 1985 - 29 Feb. 1988**
Robert L. Byers Mar. 1988 43 p
(Contract F49620-85-C-0062; AF Proj. 2301)
(AD-A200679; AFOSR-88-1089TR) Avail: NTIS HC A03/MF A01 CSCL 20F

The research proposal for this program emphasized the production of single-crystal fiber optical devices. Results are reported in the growth, processing, and characterization of single-crystal fibers, which have led to significant demonstrations of fiber laser and nonlinear optical devices. Theoretical work originally undertaken to model fiber materials and device behavior has contributed to the development of the more general concept of tailored nonlinear media. This concept, and the materials work toward understanding fiber device processing, resulted in the development of new non-linear materials through the modification of existing materials or through microscopic control of material structure during growth. GRA

**N89-17868#** University of Southern California, Los Angeles. Dept. of Electrical Engineering.
**INSTRUMENTATION FOR HIGH SPEED PHASE CONJUGATION Final Technical Report, 15 Oct. 1986 - 14 Oct. 1987**
Robert W. Hellwarth 5 Apr. 1988 4 p
(Grant AF-AFOSR-0043-87; AF Proj. 2917)
(AD-A200742; AFOSR-88-1084TR) Avail: NTIS HC A02/MF A01 CSCL 14B

With this equipment grant we have established and instrumented an optical laser source at 1.06 microns and three harmonics, with the added capability of a tunable dye laser pumped at any of these harmonics. Pulse lengths are available from 10 to 10(5) picosecond. Maximum pulse energy is 0.4 J at 1.06 microns in 4 nsec. First measurements on new optical polymers show them to be promising as stable room-temperature nonlinear optical materials. GRA

**N89-17869#** Mission Research Corp., Albuquerque, NM. Plasma Sciences Div.
**MODELS OF THE ANEURYSM IN EXPANDING LASER-PLASMA Technical Report, 2 May 1985 - 31 Jul. 1988**
Robert E. Peterkin, Jr. and Robert F. Stellingwerf 31 Jul. 1988 96 p
(Contract DNA001-85-C-0069)
(AD-A200754; MRC/ABQ-R-1031; DNA-TR-88-112) Avail: NTIS HC A05/MF A01 CSCL 20I

This report describes theoretical models of laser plasma experiments in which hot laser-irradiated target debris expands into a few Torr background gas. The most interesting characteristics of these experiments are the formation and evolution of a spherical blast wave, and in some cases, the appearance of one or more distinctive protuberances or aneurysms on the expanding wave. Many possible mechanisms for the formation of these structures have been suggested, ranging from instabilities in the blast wave itself to the effects of jets of material ejected from the target. Many of these mechanisms are of interest to the problem of early-time structuring in high altitude nuclear bursts. This report discusses a series of magnetohydrodynamic models that accurately describe this phenomenon, and identify the processes that mold

the blast wave and the aneurysm. In most cases the aneurysm can be explained by a channel heating mechanism due to inverse bremsstrahlung in the laser channel. A simple model is derived that clearly shows this effect and matches the detailed two-dimensional models as well as the experimental results. The effects of laser-target interaction, thermal conduction, radiation cooling, multiple materials, self-generated magnetic fields, and ambient magnetic fields are included and discussed. GRA

**N89-17870#** Los Alamos National Lab., NM. Chemical and Laser Sciences Div.

**XUV FREE-ELECTRON LASER DEVELOPMENT AT LOS ALAMOS**

Brian E. Newnam 1988 6 p Presented at the Linear Accelerator Conference, Williamsburg, VA, 3 Oct. 1988

(Contract W-7405-eng-36)

(DE89-005463; LA-UR-88-4163; CONF-881049-54) Avail: NTIS HC A02/MF A01

Free-electron lasers (FELs) for the vacuum-ultraviolet and soft X-ray spectral regions (together termed the XUV) are being designed at Los Alamos for integration into a future national UV/XUV FEL user facility for scientific experimentation. As proposed, this facility would consist of a sequence of up to 15 FEL oscillators and amplifiers, driven by a single, RF-linear accelerator, that will generate broadly tunable, picosecond-pulse, coherent radiation over the range from 1 to 400 nm. Below 300 nm, the peak- and average-power output of these FEL devices should surpass the capabilities of any existing, continuously tunable photon sources by many orders-of-magnitude. We describe the design parameters and predicted output of these FELs and make comparison with synchrotron radiation sources. Brief mention is given to our recent progress in developing the three primary components (electron beam, magnetic undulator, and resonator mirrors). DOE

**N89-17871#** Los Alamos National Lab., NM.

**LASER WORKING GROUP**

I. J. Bigio, N. A. Kurnit, W. R. Donaldson, K. Geissler, and T. Srinivasan-Rao (Brookhaven National Lab., Upton, NY.) 1988 7 p Presented at the Switched-power Workshop, Shelter Island, NY, 17-21 Oct. 1988

(Contract W-7405-eng-36)

(DE89-005477; LA-UR-88-4237; CONF-8810135-1) Avail: NTIS HC A02/MF A01

The laser working group considered options to deliver synchronized laser pulses of the required energy to the photocathode and laser triggered switches. These requirements actually decreased during the course of the workshop, and the values finally settled upon (less than 10 mJ in 100 fs at approximately 250 nm for the photocathode and approximately 10 mJ in 2 ps near either 250 nm or 1 micrometer for the switches) were considered to be well within the state of the art. Some development work may be required, however, to provide a system that has the desirable characteristics of stability, ease of use and low maintenance. DOE

**N89-17872#** Los Alamos National Lab., NM.

**FREE ELECTRON LASERS USING STABLE-UNSTABLE RING RESONATORS**

Mark J. Schmitt and Alan H. Paxton 1989 8 p Presented at the SPIE Conference on Optics, Electro-optics and Laser Applications in Science and Engineering: OE/LASE '89, Los Angeles, CA, 15-20 Jan. 1989

(Contract W-7405-eng-36)

(DE89-005462; LA-UR-88-4149; CONF-890145-1) Avail: NTIS HC A02/MF A01

The free electron laser (FEL) simulation code FELEX is used to examine the operation of stable-unstable FEL resonators. These resonators are stable along one transverse axis and unstable along the orthogonal transverse axis. The simulations utilize a ring resonator with an intracavity focus in the unstable plane near the center of the wiggler (close to the same axial position as the waist in the stable plane) thereby enhancing the coupling between the optical and electron beams. Asymmetric output scraping is performed in the back leg of the ring using a reflective mirror inserted from one side of the unstable axis. Resonators with relatively low equivalent Fresnel number (Absolute value of N(sub eq) is equal to or less than 10) and magnification (Absolute value of M(sub z) is approximately or equal to 1.2) are examined. Optical characteristics including the cavity mode profile at various positions inside the resonator are shown. DOE

**N89-17873#** Lawrence Livermore National Lab., CA.

**INTERFEROMETER FOR WAVE FRONT MEASUREMENTS OF LASER PULSES**

Erlan S. Bliss, Mitchel J. Goodman, and Frederick W. Holloway Apr. 1988 7 p Presented at CLEO '88: OSA/IEEE Conference on Lasers and Electro-Optics, Anaheim, CA, 25 Apr. 1988

(Contract W-7405-eng-48)

(DE89-005652; UCRL-97727; CONF-880402-10) Avail: NTIS HC A02/MF A01

A self-referencing polarization interferometer is combined with simultaneous four phase video detection to provide an instrument for rapid and accurate measurement of pulsed laser wave fronts. DOE

**N89-17874#** Lawrence Livermore National Lab., CA. Laser Isotope Separation Program.

**SIDEBAND GENERATION IN SATURATED PULSED DYE AMPLIFIERS WITH MULTIPLE CW SINGLE MODE INJECTION**

B. Comaskey, T. Daly, C. Haynam, J. Morris, J. Paisner, and R. Young Jan. 1988 19 p Presented at the SPIE O-E LASE '88: Optoelectronics and Laser Applications in Science and Engineering, Los Angeles, CA, 10-17 Jan. 1988

(Contract W-7405-eng-48)

(DE89-005654; UCRL-97892; CONF-880110-35) Avail: NTIS HC A03/MF A01

The output spectral characteristics of fully saturated pulsed dye amplifiers for multimode input waves having amplitude modulation (AM) are modeled and compared with experimental measurements. The AM input in our experiments was generated by combining the outputs of two single-mode dye lasers. The spectral output of the saturated dye amplifiers consisted of the input frequencies and several sidebands spaced by the input difference or beat frequency. For our experimental system with kiton red dye amplifiers, up to 20 percent of the output intensity was contained in these sidebands. Sideband production was observed to decrease as the beat frequency increased with a characteristic half-width of approximately 10 GHz. DOE

**N89-17875#** Lawrence Livermore National Lab., CA. Laser Isotope Separation Program.

**MEASUREMENTS OF ATOMIC OSCILLATOR STRENGTHS USING PULSED SINGLE-FREQUENCY DYE LASERS**

C. Haynam, B. Comaskey, M. Johnson, J. Paisner, and E. Worden Jan. 1988 22 p Presented at the SPIE O-E LASE '88: Optoelectronics and Laser Applications in Science and Engineering, Los Angeles, CA, 10-17 Jan. 1988 Submitted for publication

(Contract W-7405-eng-48)

(DE89-005655; UCRL-97891; CONF-880110-34) Avail: NTIS HC A03/MF A01

We have used two methods to measure the oscillator strength of the transition between the ground and 17992/cm level in Yb-174. The first technique involves exciting the transition with a laser pulse that is nearly time-bandwidth limited, of uniform intensity, and has a reproducible shape from shot to shot. The population left in the excited state after the pulse varies sinusoidally with a period that depends on the integral over time of the electric field amplitude and the transition oscillator strength. These are the Rabi oscillations that are predicted by application of the Schrodinger equation to the two-level atom. The excited-state population is probed using a two-step photoionization to the continuum. The electric field amplitude is determined from the temporal profile and the intensity of the laser pulse. The second method involves observation of the polarization rotation of a set of degenerate

sublevels brought about by a time-bandwidth limited light-shift laser. One sublevel (m sub j = 0) of the J = 1 level at 17992/cm is populated by a linearly polarized laser. A second copropagating light-shift laser, which is linearly polarized at an angle to the first laser, is tuned between 7.5 and 30 GHz off-resonance with the transition. The light-shift laser causes population to be promoted into the m sub j = + or - 1 levels by a virtual transition through the ground J = O, m sub j = O level. Two linearly polarized photoionizing lasers photoionize the population only from the m sub j = + or - 1 levels. The photoion signal oscillates sinusoidally with a period that depends only on the integrated pulse intensity, the laser detuning, and the transition oscillator strength. DOE

**N89-17606#** Raytheon Co., Sudbury, MA. Equipment Div.
**CO2 LASER RADAR SYSTEMS FOR TARGET ACQUISITION AND GUIDANCE**
A. V. Jelalian, G. R. Osche, D. R. Bates, and A. J. Legere *In* AGARD, Guidance and Control of Precision Guided Weapons Nov. 1988 14 p (For primary document see N89-17605 10-15)
Copyright Avail: NTIS HC A05/MF A01

**N89-17714#** Royal Signals and Radar Establishment, Malvern (England).
**COHERENT SCATTERING FROM RANDOM MEDIA**
C. J. Oliver *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 12 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

# 37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

**N89-17876** Vanderbilt Univ., Nashville, TN.
**ROBOTIC SIMULATION AND A METHOD FOR JACOBIAN CONTROL OF A REDUNDANT MECHANISM WITH IMBEDDED CONSTRAINTS Ph.D. Thesis**
Kenneth Randolph Fernandez 1988 147 p
Avail: Univ. Microfilms Order No. DA8815723

The development of effective robotic systems requires that critical issues relating to kinematic design, motion control, path planning, and dynamics be resolved. The design and implementation of ROBOSIM, a robotic simulation software tool which may be used to resolve these issues are investigated. Several NASA related robotic systems studies are also summarized.
Dissert. Abstr.

**N89-17877#** Universitaet der Bundeswehr, Neubiberg (Germany, F.R.). Fachbereich Maschinenbau.
**METHOD FOR THE PRECALCULATION OF THE CHARACTERISTICS OF CENTRIFUGAL COMPRESSOR STAGES WITH SMALL FLOW RATE NUMBER Ph.D. Thesis [METHODE ZUR VORAUSBERECHNUNG DER KENNLINIEN VON RADIALVERDICHTERSTUFEN MIT KLEINER DURCHFLUSSZAHL]**
Dieter Beinecke 1988 148 p In GERMAN
(ETN-89-93486) Avail: NTIS HC A07/MF A01

A one-dimensional model for the precalculation of the characteristics of stages with low flow rate number which are preferably used in radial process compressors, was developed and applied. The results of measurements on 5 test stages with an optimal flow rate number of 0.025 were used to deduce the required correlations. The physics of the impeller flow is largely correctly described by the model; parameterizations are not necessary. The suitability of the method is demonstrated by measurements on two test stages, varying the initial conditions. Proposals for correlations are given in order to further improve the efficiency of the characteristics precalculation method. The calculation model is not restricted to stages with small flow rate number. ESA

**N89-17878#** Universitaet der Bundeswehr, Neubiberg (Germany, F.R.). Fachbereich Maschinenbau.
**A METHOD FOR THE DIGITAL SIMULATION OF UNSTEADY PHENOMENA IN COMPRESSOR SYSTEMS Ph.D. Thesis [EIN VERFAHREN ZUR DIGITALEN SIMULATION INSTATIONAERER VORGAENGE IN VERDICHTERANLAGEN]**
Norbert Aust 1988 217 p In GERMAN
(ETN-89-93488) Avail: NTIS HC A10/MF A01

A method for the simulation of the behavior of compressor systems in unsteady operation was developed. For the verification of this method a test stand was built, consisting of a turbocompressor, pipes of different diameters, containers, and throttle resistances. The compressor is described by its characteristics which are experimentally determined. In the throttle elements there is compressible but subcritical flow. The global, experimentally determined characteristic field can be precisely simulated by a valve constant and a parameter describing the valve position. The measurements of the pump cycles are characterized by the occurrence of overshoots which have a bad effect on the global process. The clear tendencies which were experimentally recognized during the variation of the operational parameters, are again completely found in the simulations. ESA

**N89-17879#** Karlsruhe Univ. (Germany, F.R.). Fakultaet Maschinenbau.
**AERODYNAMIC SPRING SUPPORTS FOR HIGH RATES OF ROTATION AND HIGH TEMPERATURES Ph.D. Thesis [AERODYNAMISCHE FEDERLAGER FUER HOHE DREHZAHLEN UND HOHE TEMPERATUREN]**
Bernhard Breunig 1986 201 p In GERMAN
(ETN-89-93493) Avail: NTIS HC A10/MF A01

Four spring support types of construction are presented and the design fundamentals are outlined, for applications in small thermal turbomachines. The static and dynamic support characteristics were calculated using the Reynolds differential equation for compressible media. The temperature distribution in the support, the resulting thermal-elastic deformations, and their effect on the relevant support parameters were calculated. Systematic parameter variations were used to determine design guidelines for an efficient support and shaft cooling with which unacceptable thermal deformations can be avoided. Experiments on rotor test stands demonstrate the operational safety of the support in a broad range of rotation rates (up to 100,000 rpm) and at high temperatures (up to 500 C). ESA

**N89-17880#** Institut National des Sciences Appliquees, Lyon (France). Lab. de Mecanique des Structures.
**PREDICTION OF THE DYNAMIC BEHAVIOR OF ROTORS IN THE CASE OF PERIODIC COEFFICIENT EQUATIONS: INSTABILITY-RESPONSE TO ECCENTRICITY Ph.D. Thesis [PREDICTION DU COMPORTEMENT DYNAMIQUE DE ROTORS DANS LE CAS D'EQUATIONS A COEFFICIENTS PERIODIQUES: INSTABILITE-REPONSE AUX BALOURDS]**
Pierre-Michel Guilhen 1988 147 p In FRENCH
(ISAL-88-0026; ETN-89-94098) Avail: NTIS HC A07/MF A01

Asymmetric rotors which are linear systems with periodic coefficients are studied. The method used to find the unstable regions is based on an extension of the Floquet theory and the utilization of the transfer matrices. The response to eccentricity is calculated step by step by a Newark implicit formulation. Industrial applications are presented. The results obtained are good and prove the interest of the method. ESA

**N89-17881#** Institut National des Sciences Appliquees, Lyon (France). Lab. de Mecanique des Structures.
**DYNAMIC BEHAVIOR OF A ROTOR PASSING THROUGH CRITICAL VELOCITIES Ph.D. Thesis [COMPORTEMENT DYNAMIQUE D'UN ROTOR AU PASSAGE DES VITESSES CRITIQUES]**
Jacques Lacroix 1988 163 p In FRENCH Sponsored by CNRS, France and the Direction des Recherches Etudes et Techniques, Paris, France
(ISAL-88-0043; ETN-89-94100) Avail: NTIS HC A08/MF A01

The transient behavior of a rotating machine was studied. A modal reduction method is included in the algorithm and the numerical integration method is that of Newmark. The influence of several parameters is analyzed, including acceleration, eccentricity, and dumping. An experimental device developed to observe real rotors passing through critical velocities is described. The agreement of the observed phenomena with the predicted behavior is quite satisfactory. ESA

**N89-17882#** Sandia National Labs., Albuquerque, NM.
**MODEL VALIDATION OF THE SANDIA 34-METER TEST BED TURBINE USING SUBSTRUCTURE MODAL-TESTING**
Thomas G. Carne, James P. Lauffer, Anthony J. Gomez, and Thomas D. Ashwill 1989 6 p Presented at the ASME Energy-sources Technology Conference and Exhibition; and 7th Intersociety Cyrogenic Symposium, Houston, TX, 22 Jan. 1989
(Contract DE-AC04-76DP-00789)
(DE89-004040; SAND-88-1774C; CONF-890102-11) Avail: NTIS HC A02/MF A01

The Sandia 34-Meter Test Bed Turbine is a vertical-axis wind turbine, thirty-four meters in diameter, designed to provide a test-bed for research in aerodynamics, structures and control. In order to design a large wind turbine, knowledge of the modal frequencies and mode shapes is essential for predicting structural response. During the design, analytical or finite element models are utilized for estimates of these modal parameters. However, when hardware becomes available, modal testing can be used to verify or update the models. The concept of substructure modal testing was developed for the Sandia 34-Meter Test Bed in order to more fully evaluate the accuracy of the finite element model. Instead of performing only one test on the entire turbine, separate tests and analyses were performed on major substructures of the turbine, including three separate blade sections, the tower supported by the guy cables, and the entire turbine. The results were then compared to analytical predictions from the finite element models of the substructures and the entire turbine. DOE

**N89-17883#** Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
**SCIENTIFIC-TECHNICAL CONFERENCE ON THE STATIC AND DYNAMIC STRENGTH OF ENGINES. QUESTIONS OF THE STRENGTH OF ENGINES**
Ye. I. Bopdyrev 29 Sep. 1988 12 p Transl. into ENGLISH from Problemy Prochnosti (USSR), no. 7, Jul. 1970 p 100-101 Conference held in Leningrad (USSR), 10-11 Mar. 1970
(AD-A200798; FTD-ID(RS)T-0559-88) Avail: NTIS HC A03/MF A01 CSCL 21E

A scientific-technical conference on the static and dynamic strength of engines is discussed. The discussion was sponsored by the Scientific Council for Strength and Plasticity of the AS USSR 10 to 11 March 1970 in Leningrad consisting of a scientific-technical conference on the static and dynamic strength of engines. In the work of conference approximately 300 scientists and specialists participated, as well as the representatives of scientific institutions, Institutes of Higher Education and industrial enterprises of Moscow, Leningrad, Kiev, Novosibirsk, Kuybyshev, Kharkov, Chelyabinsk, Sverdlovsk, Perm' and other cities of the Soviet Union. GRA

**N89-17884#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.
**FRICTION PHENOMENON IN CONTACT STRESS PROBLEMS Final Report**
D. Post and J. N. Reddy 1 Jul. 1988 203 p
(Contract N00014-84-K-0552)
(AD-A200806) Avail: NTIS HC A10/MF A01 CSCL 11D

Numerical, experimental, and hybrid combinations of these methods, were used to study plane contact problems. The experimental program used moire interferometry to determine in-plane displacement fields near the contact boundaries of pin-loaded aluminum and graphite-epoxy plates. The experiments closely modeled two dimensional behavior and introduced zero-thickness gratings (for the aluminum plate). The experimental data were reduced by means of a localized hybrid analysis which used the experimental displacement data as input to a finite element analysis of selected zones of interest. The stress distributions obtained were generally consistent with those of published analytical and experimental studies but the detailed frictional phenomena were found to be very localized and somewhat irregular. The composite plate program featured a failure analysis based upon the experimentally determined stress distributions. These distributions were combined with a maximum stress failure criterion to predict the mode and location of the failure. The results of an earlier experiment were used to assess the accuracy of a general finite element algorithm for plane elastic problems. On the basis of this comparison refinements to the solution methodology were made. GRA

**N89-17885#** Idaho National Engineering Lab., Idaho Falls.
**COMPARISON OF SIMULATION AND TEST FOR ELECTRIC VEHICLES OF RECENT DESIGN**
A. F. Burke 1988 7 p Presented at the International Congress and Exposition of the Society of Automotive Engineers, Inc., Detroit, MI, 27 Feb. 1989
(Contract DE-AC07-76ID-01570)
(DE89-005409; EGG-M-88342; CONF-890240-1) Avail: NTIS HC A02

Comparisons have been made between data obtained from dynamometer tests of various electric vehicles and computer simulations of the same vehicle-battery combinations for several driving cycles. The vehicles included in the study were the ETV-1, Bedford Van, Unique Mobility, ETX-1 and DSEP(TB-1). The batteries studied were the ALCO 2200, Gel/cel 3, EV5T, ETX-100(CHL12), and the NIF-170. The comparisons indicated that the energy consumption values obtained using ELVEC agree within 10 percent with test data for both constant speed and variable power driving schedules. The range comparisons were less consistent, but the predictions agreed with the data to within 10 percent if the vehicle battery was in good condition and the controller did not limit battery power at low states-of-charge. Second-by-second comparisons of measured and calculated values of battery power and current during transient vehicle operation showed the agreement worse than would have been expected based on the good agreement found for cycle energy consumption. Further development of ELVEC is needed to complete its validation as an electric vehicle simulation code. DOE

**N89-17686#** National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.
**LITERATURE REVIEW ON THE DESIGN OF MECHANICALLY FASTENED COMPOSITE JOINTS**
C. Poon *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 28 p Previously announced as N87-12872 (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-18398*#** National Aeronautics and Space Administration, Washington, DC.
**AUTOMATION AND ROBOTICS**
Melvin Montemerlo *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 1-28 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 13I

# 38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

**N89-17886#** Universite de Technologie de Compiegne (France). Dept. de Genie Informatique.
**DETECTION AND RECOGNITION OF DEFECTS IN NONDESTRUCTIVE TESTS WITH EDDY CURRENTS Final Report [DETECTION ET RECONNAISSANCE DE DEFAUTS EN CONTROLE NON DESTRUCTIF PAR COURANTS DE FOUCAULT]**
P. Gaillard, P. Simard, and N. Colin 14 Oct. 1988 102 p In FRENCH
(Rept-85/044; ETN-89-94093) Avail: NTIS HC A06/MF A01

The use of Eddy current methods in quality control of turbine rotor blades is described. The algorithm is composed of six sub-programs and is based on the analysis of changes of impedance in the complex plane. A file describing the defect along 24 lines of 50 points each is formed. It is shown that the localization of the defects is quite accurate. It is already possible to identify automatically 60 pct of the detected defects (distinction between crack and erosion). ESA

**N89-17887#** Ames Lab., IA.
**AN AUTOMATED MULTIVIEWING ULTRASONIC TECHNIQUE FOR FLAW RECONSTRUCTION**
D. O. Thompson, D. K. Hsu, and S. J. Wormley 1987 16 p Presented at the 5th Symposium on Energy Engineering Sciences, Argonne, IL, 17 Jun. 1987
(Contract W-7405-eng-82)
(DE89-003733; IS-M-607; CONF-870679-5) Avail: NTIS HC A03/MF A01

This paper describes key achievements in the development of an automated multiviewing ultrasonic instrumentation for flaw characterization in materials. Based on ultrasonic signals scattered from the flaw in a number of directions, the signal processing algorithms provide a reconstruction of the size, shape, and orientation of the flaw. To improve the reconstruction reliability for arbitrarily oriented flaws, an angular scan plan is developed to select the most favorable data acquisition aperture configuration for a given flaw. Reconstruction results are presented. Electronic circuits are developed for the generation and detection of broadband unipolar ultrasonic pulses in order to characterize flaws over a wider size range. A second generation multiview transducer has been developed to incorporate these capabilities. The instrumentation and the associated signal processing algorithms form a unique research and inspection tool. DOE

**N89-17888#** Ohio State Univ., Columbus.
**EFFECTS OF ASSUMING INDEPENDENT COMPONENT FAILURE TIMES, IF THEY ARE ACTUALLY DEPENDENT, IN A SERIES SYSTEM Final Report, 1 Sep. 1982 - 31 Dec. 1987**
Melvin L. Moeschberger and John P. Klein May 1988 295 p
(Grant AF-AFOSR-0307-82; AF Proj. 2304)
(AD-A200892; AFOSR-88-1001TR) Avail: NTIS HC A13/MF A01 CSCL 12C

The overall objective of this proposal is to develop improved estimation techniques for us in reliability studies when there are competing failure modes or competing causes of failure associated with a single failure mode in date from series systems. Such improved nonparametric estimators of the component failure distribution will be accomplished by incorporating some dependence structure between the potential component failure times. The first specific aim is to investigate techniques which identify departures from independence, based on data collected from series systems, by making some restrictive assumptions about the structure of the system, and obtain modified nonparametric estimators which incorporate some restrictive assumptions about the structure of the system. The second aim will be to develop improved nonparametric estimators of component lifetimes by obtaining modifications of the product limit estimator which incorporate some parametric information and by studying the robustness of these estimators to misspecification of the parametric model. Competing risk analyses have been performed in the past and will continue to be performed in the future. This study will provide the user of such techniques with an alternative to the usual approach of assuming independent risks, an assumption which most of the methods currently in use assume. GRA

# 39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

**N89-17889#** International Centre for Theoretical Physics, Trieste (Italy).
**DISLOCATION DISTRIBUTION FUNCTION NEAR A CRACK TIP GENERATED BY EXTERNAL SOURCES**
C. W. Lung and K. M. Deng Jun. 1988 10 p
(DE88-704230; IC-88/130) Avail: NTIS (US Sales Only) HC A02/MF A01

The dislocation distribution function near a crack tip generated by external sources is calculated. It is similar to the shape of curves calculated for the crack tip emission case but the quantative difference is quite large. The image forces enlarges the negative dislocation zone but does not change the form of the curve. DOE

**N89-17890#** Japan Atomic Energy Research Inst., Tokyo. Dept. of Reactor Safety Research.
**DUCTILE FRACTURE BEHAVIOR OF 3-INCH DIAMETER CARBON STEEL PIPING WITH A CIRCUMFERENTIAL THROUGH-WALL CRACK UNDER BENDING LOAD**
Noriyuki Tyujyo, Katsuyuki Shibata, Kunio Onizawa, Takaichi Kawamura, Toshihiro Ohba, and Shohachiro Miyazono Jul. 1988 125 p In JAPANESE; ENGLISH summary
(DE88-755229; JAERI-M-88-130) Avail: NTIS (US Sales Only) HC A06/MF A01

In order to introduce Leak-Before-Break (LBB) concept into the piping design criteria of the LWR pressure boundary pipings, it is necessary to investigate the pipe fracture behaviors, such as fracture condition and crack opening area, etc. At JAERI, pipe fracture tests of stainless steel and STS42 carbon steel pipes under bending load have been conducted as a part of the LBB research program. This report summarizes the four-point bending test results of 3-inch diameter STS42 carbon steel pipe with a circumferential through-wall crack. Tests were carried out at room temperature. In the tests, the fracture behavior of pipes was investigated to evolute the validity of Net-section collapse criterion, J-R curve and crack opening area. It is shown that the Net-section collapse criterion gives a conservative evaluation for the fracture load of 3-inch diameter carbon steel pipes. DOE

**N89-17891#** Sandia National Labs., Albuquerque, NM.
**AN UNCERTAINTY ANALYSIS FOR THE STRUCTURAL MECHANICS LABORATORY**
Richard L. Crabb 1988 6 p Presented at the Experimental Mechanics in Manufacturing and Quality Control, Indianapolis, IN, 6 Nov. 1988
(Contract DE-AC04-76DP-00789)
(DE89-001816; SAND-88-2847C; CONF-881174-3) Avail: NTIS HC A02/MF A01

An investigation of the uncertainties associated with instrumentation used in a structural mechanics laboratory is outlined in this report. Results from studies made to quantify measurement data and various uncertainty factors related to randomness, load cells, linear variable differential transformers (LVDTs) and data collection devices show that the overall uncertainty is of the order of one or two percent. The subject of measurement traceability is

discussed followed by a description of the system, analysis, and conclusions. DOE

**N89-17892*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**MEASURED AND PREDICTED ROOT-MEAN-SQUARE ERRORS IN SQUARE AND TRIANGULAR ANTENNA MESH FACETS**
W. B. Fichter Washington, DC Mar. 1989 17 p
(NASA-TP-2896; L-16525; NAS 1.60:2896) Avail: NTIS HC A03/MF A01 CSCL 20K

Deflection shapes of square and equilateral triangular facets of two tricot-knit, gold plated molybdenum wire mesh antenna materials were measured and compared, on the basis of root mean square (rms) differences, with deflection shapes predicted by linear membrane theory, for several cases of biaxial mesh tension. The two mesh materials contained approximately 10 and 16 holes per linear inch, measured diagonally with respect to the course and wale directions. The deflection measurement system employed a non-contact eddy current proximity probe and an electromagnetic distance sensing probe in conjunction with a precision optical level. Despite experimental uncertainties, rms differences between measured and predicted deflection shapes suggest the following conclusions: that replacing flat antenna facets with facets conforming to parabolically curved structural members yields smaller rms surface error; that potential accuracy gains are greater for equilateral triangular facets than for square facets; and that linear membrane theory can be a useful tool in the design of tricot knit wire mesh antennas. Author

**N89-17893** Texas Univ., Austin.
**AVERAGING FOR PROBABILISTIC NONLINEAR STRUCTURAL DYNAMIC PROBLEMS Ph.D. Thesis**
John Robert Red-Horse 1988 155 p
Avail: Univ. Microfilms Order No. DA8816550

The statistics of the response of various problems of interest in random vibration analysis are investigated. Specifically, a class of lightly damped single degree of freedom oscillators, each of which is characterized by an additive nonlinear stiffness term and subjected to an external random excitation which possesses an evolutionary power spectral density is first considered. Central to this analysis, is a generalization of the stochastic averaging technique which allows, based on the assumption of small damping and excitation levels, an appropriately defined envelope and phase to be averaged. The resulting averaged equations represent, asymptotically, Markov processes and as such are assumed to have time dependent properties that are governed by the forward Kolmogorov equation. These techniques are subsequently applied to a particular kind of two degree of freedom oscillator. An analysis of a particular form of two degree of freedom oscillator is performed. Dissert. Abstr.

**N89-17894** California Univ., Berkeley.
**THE NORMAL IMPACT OF A ROD-MASS SYSTEM ON A VISCOELASTIC LAYERED HALF SPACE; A MODEL FOR WIRE-MATRIX PRINTING Ph.D. Thesis**
Harold Alan Downey, Jr. 1987 150 p
Avail: Univ. Microfilms Order No. DA8813854

Wire matrix printing is reduced to an idealized model, a one-dimensional rod with a lumped mass representing the wire, a viscoelastic layer representing the paper and ribbon, and an elastic half space representing the platen. The method of solution reduces the problem to integral equations for the average contact stress and the displacement of the rod tip into the contact surface. The kernels of these integral equations are composed of Green's functions for the rod and the layered half space. The solution of the problem therefore has two parts. The first is concerned with deriving the Green's function. The second involves the numerical solution of the integral equations, which are solved with a second order stable scheme. The solution of the problem is computed for a wide variety of materials and configurations, providing the stress and displacement history, as well as the stress displacement response. The results show the effects of changes in rod material and length, lumped mass, layer material, substrate material, and viscoelasticity. Dissert. Abstr.

**N89-17895** Cranfield Inst. of Tech., Bedford (England).
**STUDIES INTO THE FAILURE PREDICTION OF BRITTLE MATERIALS Ph.D. Thesis**
P. D. Nguyen 1987 294 p
Avail: Univ. Microfilms Order No. BRDX82216

Five different failure criteria were utilized in the initial analysis. Various statistical fracture models were used to analyze the failure of brittle materials under multiaxial states of stress, the experimental failure data for simple tension being a starting point for their calculation. The study investigates methods of evaluating the Weibull parameters which were crucial in the failure prediction of brittle materials. Monte Carlo simultation techniques are also presented as a method of evaluating the data ranking for the failure probability of brittle materials. Experimental techniques adopted in the study, using specially designed rigs were described. Six different tests were conducted to evaluate the performance of brittle materials in static loading and also to evaluate comparisons with the theoretical predictions. Attention was given to specimen casting, loading frames, alignment, measurement techniques, and other relevant parameters. The use of the linear elastic fracture mechanics method to predict the behavior of cracks in bodies, which are subjected to steady stresses, is discussed. The compliance function for the three-point notch bend specimen is presented in addition to the determination of the fracture toughness of Herculite LX plaster. The work was also supplemented by the use of scanning electron microscopy (SEM) to failure analysis of plaster materials. The theoretical results as well as the experimental findings were analyzed. Dissert. Abstr.

**N89-17896** Georgia Inst. of Tech., Atlanta.
**IDENTIFICATION OF DISTRIBUTED PARAMETER SYSTEMS WITH DAMPING Ph.D. Thesis**
R. Chander 1988 177 p
Avail: Univ. Microfilms Order No. DA8820811

Structural dynamic system identification procedures for obtaining accurate analytical models are generally formulated for discrete systems rather than for continuous or distributed systems. To date, little effect has been made in developing identification methods applicable to distributed structural dynamic systems. The existing techniques can be classified according to the type of data being used, namely frequency domain, time domain or modal data. An identification scheme in the frequency domain using B-splines and cardinal splines, suitable for damped and distributed structural dynamic systems, is presented. The parameters appearing in the governing equation are assumed to be spatially varying functions. To estimate the system parameters, the equation-error method is used. This technique may not require a priori knowledge of the parameters, unlike the iterative techniques. Both numerically simulated responses and experimental data are used to validate the identification procedures. Dissert. Abstr.

**N89-17897** Georgia Inst. of Tech., Atlanta.
**WHOLE FIELD OPTICAL METHODS FOR STRUCTURAL MECHANICS: DIGITAL SPECKLE CORRELATION AND LASER DOPPLER VELOCIMETRY Ph.D. Thesis**
P. Sriram 1988 244 p
Avail: Univ. Microfilms Order No. DA8820828

Two new distributed sensing techniques were developed, namely a scanning laser Doppler velocimeter for structural applications and a digital speckle correlation method for measurement of displacement along the line of sight. In the first technique, an oscillating mirror scanner was designed and used with a commercial LDV to obtain distributed velocity measurements. In the second technique, a digital speckle correlation system was developed for measurement of out of plane deflections of initially flat structures. Dissert. Abstr.

**N89-17898*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**EAC: A PROGRAM FOR THE ERROR ANALYSIS OF STAGS RESULTS FOR PLATES**
Rajaram Sistla, Gaylen A. Thurston, and Nancy Jane C. Bains Jan. 1989 74 p
(NASA-TM-100640; NAS 1.15:100640) Avail: NTIS HC A04/MF A01 CSCL 20K

A computer code is now available for estimating the error in results from the STAGS finite element code for a shell unit consisting of a rectangular orthotropic plate. This memorandum contains basic information about the computer code EAC (Error Analysis and Correction) and describes the connection between the input data for the STAGS shell units and the input data necessary to run the error analysis code. The STAGS code returns a set of nodal displacements and a discrete set of stress resultants; the EAC code returns a continuous solution for displacements and stress resultants. The continuous solution is defined by a set of generalized coordinates computed in EAC. The theory and the assumptions that determine the continuous solution are also outlined in this memorandum. An example of application of the code is presented and instructions on its usage on the Cyber and the VAX machines have been provided. Author

**N89-17899*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.
**CALCULATION OF SKIN-STIFFENER INTERFACE STRESSES IN STIFFENED COMPOSITE PANELS Interim Report**
David Cohen and Michael W. Hyer Dec. 1987 193 p
(Grant NAG1-343)
(NASA-CR-184682; NAS 1.26:184682; CCMS-87-17; VPI-E-87-32; IR-68) Avail: NTIS HC A09/MF A01 CSCL 20K

A method for computing the skin-stiffener interface stresses in stiffened composite panels is developed. Both geometrically linear and nonlinear analyses are considered. Particular attention is given to the flange termination region where stresses are expected to exhibit unbounded characteristics. The method is based on a finite-element analysis and an elasticity solution. The finite-element analysis is standard, while the elasticity solution is based on an eigenvalue expansion of the stress functions. The eigenvalue expansion is assumed to be valid in the local flange termination region and is coupled with the finite-element analysis using collocation of stresses on the local region boundaries. Accuracy and convergence of the local elasticity solution are assessed using a geometrically linear analysis. Using this analysis procedure, the influence of geometric nonlinearities and stiffener parameters on the skin-stiffener interface stresses is evaluated. Author

**N89-17900#** Sandia National Labs., Albuquerque, NM. Electromechanical Subsystems ESD Div.
**INSTRUMENTATION USES TO DETERMINE STRUCTURAL RESPONSES UNDER VARIOUS TEST CONDITIONS**
Alexander Gonzales Jan. 1989 40 p
(Contract DE-AC04-76DP-00789)
(DE89-005297; SAND-87-2645) Avail: NTIS HC A03/MF A01

Sandia National Laboratories standardly approaches design and analysis problems by testing various components and prototypes. Instrumentation is used in impact, dynamic, and static testing to gather information about the structural response of a component or prototype. This report describes the most common measurement devices used, and discusses the uncertainties associated with the reduced data. DOE

**N89-17901#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Mechanik.
**DESIGN OF CONTROLLERS FOR ACTIVE VIBRATION DAMPING IN FLEXIBLE MECHANICAL STRUCTURES Ph.D. Thesis [ENTWURF VON REGLERN ZUR AKTIVEN SCHWINGUNGSDAEMPFUNG AN FLEXIBLEN MECHANISCHEN STRUKTUREN]**
Johannes Schmidt 1987 133 p In GERMAN
(ETN-89-93499) Avail: NTIS HC A07/MF A01

The design of controllers for the active damping of vibrations in structural components which can be modelled as one-dimensional continua, described by partial differential equations, of the hyperbolic type was investigated. The basic control element produces, in a point of the component, regulating variables which maximize the energy flow to the actuator. The control laws result from the analysis of the energy flow to the actuator. The control laws were tested in numerical simulations. The advantages of the control concept are based on the fact that the regulating variables in the control laws of the structure occur only in the neighborhood of the actuator. The representation of the hyperbolic equations of motion in the normal form is not only efficient for the treatment of control problems, but also for the investigation of the dispersion. ESA

**N89-17902#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Mechanik.
**THE STRESS PROBLEM IN A THIN WALLED HYPERBOLOID OF REVOLUTION Ph.D. Thesis [ZUM SPANNUNGSPROBLEM DUENNWANDIGER ROTATIONSHYPERBOLOIDE]**
Hans-Georg Radtke 1987 114 p In GERMAN
(ETN-89-93505) Avail: NTIS HC A06/MF A01

Approximated shell theory formulas were analytically deduced for a special shell with hyperbolically curved center surfaces. The starting points were linear shell equations in the Donnell-Marquerre approximation. An asymptotic series of differential equations with constant coefficients was developed; they can be successively solved if the boundary conditions are fulfilled. The numerical results of this method were compared with finite element results. ESA

**N89-17903#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Mechanik.
**EIGENFREQUENCIES OF A SHELL WITH A HYPERBOLOID-OF-REVOLUTION FORM WITH WEEK MERIDIAN CURVATURE Ph.D. Thesis [EIGENFREQUENZEN VON ROTATIONSHYPERBOLOIDSCHALEN MIT SCHWACHER MERIDIANKRUEMMUNG]**
Christian Braeutigam 1987 110 p In GERMAN
(ETN-89-93506) Avail: NTIS HC A06/MF A01

Formulas for the approximate determination of the lowest eigenfrequencies of weakly curved shells in the form of a hyperboloid of revolution were developed, starting from a geometrically and physically linear shell theory. Numerical calculations show that the tangential inertial forces can be neglected, thereby reducing basic shell theory equations to two. For weak curvatures, the differential equations can be developed using a small hyperboloid parameter, which, together with additional simplification, leads to usable formulas for the approximate calculation of the lowest eigenfrequencies. The results agree well with numerical solutions in a broad parameter domain. ESA

**N89-17904#** Applied Research Associates, Inc., South Royaltan, VT.
**EXPERIMENTAL AND THEORETICAL RESPONSE OF MULTIPHASE POROUS MEDIA TO DYNAMIC LOADS Final Report**
Kwang J. Kim, Scott E. Blouin, Daniel E. Chitty, and Douglas H. Merkle 1 Sep. 1988 242 p
(Contract F49620-85-C-0102)
(AD-A200936; ARA-5967 -88; AFOSR-88-1004TR) Avail: NTIS HC A11/MF A01 CSCL 20K

This report summarizes results of a combined experimental/theoretical/numerical study of the response of multiphase porous media subjected to high intensity static and dynamic loads. Theoretical models for fully coupled porous skeletons subjected to static and dynamic loads are developed for saturated and partially saturated conditions. These theoretical models are incorporated into numerical codes which are used in a systematic study of multiphase response which includes: modeling of liquefaction in saturated soils and rocks; wave propagation in saturated porous media, including modeling of compressional waves of the first and second kind; and the role of pore fluid in damping, wavespeed and liquefaction as a function of the material properties of the porous skeleton. GRA

**N89-17905#** Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
**BRITTLE-TO-DUCTILE TRANSITION IN CLEAVAGE FRACTURE Progress Report**
Ali S. Argon 1989 5 p
(Contract DE-FG02-87ER-45294)
(DE89-005737; DOE/ER-45294/T2) Avail: NTIS HC A02/MF A01

The basic direction of the research remains to be a dual approach combining an experimental investigation of the crack arrest temperatures in the cleavage fracture of samples of different crystal structure, with modeling of the crack tip dislocation emission process. The principal thesis is that a brittle cleavage to ductile behavior transition of fracture in intrinsically brittle solids is governed by crack tip processes that are controlled either by the energy barriers to the nucleation of dislocation loops from crack tips or the mobility of the nucleated dislocations away from the tip. It is anticipated that in a metallic material such as Fe 3 percent Si the process will be the former, while in Si it is already known that it is latter. The situation is unknown for intermetallic compounds such as Ni Al which is also under investigation. In the remainder of this renewal proposal we start out by giving a brief progress report about both the experiments and the theoretical modeling research. This is followed by a brief program of proposed research. DOE

**N89-17906#** California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Chemical Sciences Div.
**INITIAL RESEARCH REGARDING ISOTHERMAL SHEAR FATIGUE OF SOLDER JOINTS M.S. Thesis**
M. T. McCormack May 1988 35 p Prepared in cooperation with California Univ., Berkeley
(Contract DE-AC03-76SF-00098)
(DE89-004654; LBL-26177) Avail: NTIS HC A03/MF A01

This work presents a versatile load frame apparatus constructed to provide the capabilities needed for performing isothermal shear fatigue of solder joints in a variety of thermal environments. Initial isothermal data from -55 C to 125 C gathered with 60Sn-40Pb and 5Sn-95Pb solder joints are then furnished to illustrate simple use of the apparatus. DOE

**N89-17687#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Helicopter and Airplane Div.
**COMPARISON OF EXPERIMENTAL RESULTS AND ANALYTICALLY PREDICTED DATA FOR DOUBLE SHEAR FASTENED JOINTS**
J. Bauer and E. Mennle *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 8 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17688#** Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.
**RECENT STUDIES ON BOLTED JOINTS IN COMPOSITE STRUCTURES**
V. B. Venkayya, R. L. Ramkumar (Northrop Corp., Hawthorne, CA.), V. A. Tischler, B. D. Snyder, and J. G. Burns *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 14 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17689#** Politecnico di Milano (Italy). Dipartimento di Ingegneria Aerospaziale.
**DAMAGE GROWTH IN COMPOSITE BOLTED JOINTS**
V. Giavotto, C. Caprile, and G. Sala *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 12 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17690#** Technische Hogeschool, Delft (Netherlands). Faculty of Aerospace Engineering.
**STRESSES IN PINLOADED ANISOTROPIC PLATES**
Th. deJong *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 17 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17692#** Northrop Corp., Hawthorne, CA. Aircraft Div.
**STRENGTH ANALYSIS OF MECHANICALLY FASTENED COMPOSITE STRUCTURES**
R. L. Ramkumar, E. S. Saether, K. Appa, and V. B. Venkayya (Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH.) *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 22 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17694#** Service Techniques des Programmes Aeronautiques, Paris (France).
**IMPROVEMENT OF SPECIFIC FASTENING ELEMENTS FOR ASSEMBLING COMPOSITE STRUCTURES [MISE AU POINT D'ELEMENTS DE FIXATION SPECIFIQUES POUR ASSEMBLAGES DES STRUCTURES COMPOSITES]**
Raymond Louis *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 31 p In FRENCH (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17697#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**BEARING-BYPASS LOADING ON BOLTED COMPOSITE JOINTS**
J. H. Crews, Jr. and R. A. Naik (PRC Kentron, Inc., Hampton, VA.) *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 13 p (For primary document see N89-17685 10-31)
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**N89-17698#** Construcciones Aeronauticas S.A., Madrid (Spain).
**BOLTED JOINTS IN COMPOSITES PRIMARY STRUCTURES**
A. Rutz *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 8 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17700#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Helicopter and Airplane Div.
**MECHANISM OF SINGLE SHEAR FASTENED JOINTS**
J. Bauer *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 6 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17703#** Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt (Germany, F.R.).
**EFFECT OF ENVIRONMENT AND IMPROVEMENT MEASURES ON STATIC AND FATIGUE STRENGTH OF BOLTED CFRP-JOINTS**
J. J. Gerharz and H. Huth *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 16 p (For primary document see N89-17685 10-31)
Copyright Avail: NTIS HC A14/MF A01

**N89-17704#** Politecnico di Milano (Italy). Dipartimento di Ingegneria Aerospaziale.
**STIFFNESS AND RESIDUAL STRENGTH VARIATIONS ON MECHANICAL JOINTS IN CFRP SPECIMENS IN CYCLING LOADING**
C. Caprile and G. Sala *In* AGARD, Behaviour and Analysis of Mechanically Fastened Joints in Composite Structures Mar. 1988 24 p (For primary document see N89-17685 10-31)
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# 42 GEOSCIENCES (GENERAL)

**N89-17907#** Joint Publications Research Service, Arlington, VA.
**JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: EARTH SCIENCES**
8 Sep. 1988 15 p Transl. into ENGLISH from various Russian articles
(JPRS-UES-88-003) Copyright Avail: NTIS HC A03/MF A01

Translations of articles from various Russian periodicals are presented. The main subject headings under Earth Sciences are: Geology, Oceanography; and Physics of the Atmosphere. Some representative titles are: Deep Magnetotelluric Sounding of Aleutian Island Arc; Stationary Power Spectra of Two-Dimensional Turbulence in Single Layer Ocean with Free Surface on beta-Plane; and Attenuation and Absorption of Radiation by Optically Soft Cylindrical Particles. For individual titles, see N89-17908 through N89-17929.

**N89-17908#** Joint Publications Research Service, Arlington, VA.
**DEEP MAGNETOTELLURIC SOUNDING OF ALEUTIAN ISLAND ARC Abstract Only** **c46**
Yu. F. Moroz *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 1 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Zemli (Moscow, USSR), no. 1, Jan. 1988 p 96-99 (For primary document see N89-17907 10-42)
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It is postulated that a conducting layer is present in the upper mantle of the island arcs. Numerous electromagnetic soundings were made in such areas, but they are extremely difficult to interpret due to the anomalous effects arising due to redistribution of the electromagnetic field in arc regions. An interpretation is given of the magnetotelluric field in the Aleutian island arc. In a first approximation, the geoelectric model of an arc is represented in the form of a two-dimensional inhomogeneous model. The model used had an inhomogeneous upper layer underlain by a normal deep section, including a conducting layer in the upper mantle at a depth of 100 to 170 km. An analysis of the 2-D model revealed that detection of the upper mantle layer is possible only by using longitudinal curves and the results indicated only limited possibilities of magnetotelluric sounding due to the strong induction effect. A three-dimensional modeling was carried out also. The results are given and compared with the results of the 2-D model. Author

**N89-17909#** Joint Publications Research Service, Arlington, VA.
**POSSIBILITIES OF INTERPRETING MAGNETOTELLURIC SOUNDINGS FROM PHASE CURVES Abstract Only** **c46**
V. G. Sekriyeru, G. V. Molochnov, and Yu. N. Kozulin *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 1-2 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Zemli (Moscow, USSR), no. 1, Jan. 1988 p 100-103 (For primary document see N89-17907 10-42)
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In contrast to commonly used procedures, a more graphic representation of the geoelectric section in magnetotelluric sounding can be obtained by using the dependence of these parameters on the effective depth of penetration of the electromagnetic field. In addition, it is possible to interpret magnetotelluric sounding data from special graphs in the field without invoking complex interpretation procedures. These new findings encouraged research along these lines in the example of two- and three-layered media. Four types of three-layered medium are described. An analysis of these different variants indicates that the use of phase curves together with amplitude curves for interpreting the results of magnetotelluric sounding data for obtaining information on the geoelectric section in the field is feasible. Author

**N89-17910#** Joint Publications Research Service, Arlington, VA.
**PRINCIPAL PROBLEMS IN UPGRADING QUALITY AND EFFICIENCY OF GEOLOGICAL SURVEY WORK Abstract Only** **c43**
D. S. Bulayevskiy, V. A. Velikanov, D. F. Volodin, A. S. Drannik, V. N. Solovitskiy, and A. A. Frayberger *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 2 Transl. into ENGLISH from Geologicheskiy Zhurnal (Kiev, USSR), no. 2, Feb. 1988 p 3-12 (For primary document see N89-17907 10-42)
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In many areas the upper horizons have been studied to a much better degree than the deeper horizons, although the latter afford the best possibilities for detecting new mineral deposits. Materials collected during the last 13 years on geological survey work done in the Ukranian SSR is summarized. This includes the work of 80 survey parties and detachments. The types of work done and its adequacy are discussed in detail. This is followed by a discussion of some of the gaps and inadequacies in this work. Author

**N89-17911#** Joint Publications Research Service, Arlington, VA.
**STATIONARY POWER SPECTRA OF TWO-DIMENSIONAL TURBULENCE IN SINGLE-LAYER OCEAN WITH FREE SURFACE ON BETA-PLANE Abstract Only** **c48**
R. S. Iroshnikov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 4 Transl. into ENGLISH from Doklady Akademii Nauk SSSR (Moscow, USSR), v. 299, no. 2, Mar. 1988 p 312-317 (For primary document see N89-17907 10-42)
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The fundamental concept used in any description of phenomenal turbulence is that system evolution is irreversible and that it more or less rapidly forgets everything other than its integrals of motion, additive in the phase space in which the Liouville theorem is correct. A model kinetic equation in partial derivatives satisfying the laws of conservation of energy and enstrophy is proposed for describing the spectrum of two-dimensional turbulence; the energy and enstrophy flows are considered equal to zero in a state of thermodynamic equilibrium. It is shown that the beta-effect and the presence of a free surface exert an influence on evolution of total energy only due to the dependence of relaxation time on them. Stationary spectra of the Kolmogorov type were found for four cases: large- and small-scale eddy and wave turbulence. Author

**N89-17912#** Joint Publications Research Service, Arlington, VA.
**EXPERIMENTAL RESEARCH ON LOW-FREQUENCY ACOUSTIC FIELDS IN OCEAN AND EVALUATION OF POSSIBILITIES OF PREDICTING THEIR CHARACTERISTICS Abstract Only** **c48**
D. I. Abrosimov, V. S. Averbakh, L. S. Dolin, P. A. Kapustin, A. G. Luchinin, V. N. Nekrasov, A. G. Nechayev, L. A. Ostrovskiy, Ye. A. Plakhin, and A. M. Podrazhanskiy et al *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 4-5 Transl. into ENGLISH from Doklady Akademii Nauk SSSR (Moscow, USSR), v. 299, no. 2, Mar. 1988 p 477-481 (For primary document see N89-17907 10-42)
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There are still many important problems relating to the spatial-temporal structure of oceanic wave guides, both in the case of direct propagation and with scattering from wave guide inhomogeneties. Research was carried out to ascertain whether on the basis of theoretical computations based on relatively rough data on sound channel properties which can be measured experimentally, it is possible to predict real experimental data relating to important signal characteristics. The spatial and temporal structure of the direct signal and distant reverberation signals were analyzed for these different circumstances. Evidence was obtained that reverberation developed as a result of sound scattering by the sea floor and nonuniformities of the speed of sound generated in the near surface layer of the ocean by small scale turbulence.

Comparison of theoretical computations and experimental results indicated that the characteristic values of the level of distant reverberation signals can be predicted with an error of about 10 dB. Author

**N89-17913#** Joint Publications Research Service, Arlington, VA.
**METHODS FOR COMPUTING WIND AND WAVES IN TROPICAL HURRICANES Abstract Only** **c47**
K. V. Pokazeyev and M. Yu. Tyurikov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 5-6 Transl. into ENGLISH of Gidrometeorologiya. Seriya 37.25, Okeanologiya No. 1, Metody Rascheta Vetra I Voln V Tropicheskikh Uraganakh (Obninsk, USSR), 1988 p 1-48 (For primary document see N89-17907 10-42)
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Methods are discussed for the collection of information on wind and waves in tropical hurricanes and method for their computation. The most promising methods for collecting data on wind and waves in hurricanes are described. A classification of methods for computing wind and waves is proposed. The most modern and frequently used methods are described in detail and are compared. Author

**N89-17914#** Joint Publications Research Service, Arlington, VA.
**STATISTICAL CORRELATIONS OF HYDROMETEOROLOGICAL PARAMETERS OF NORWEGIAN SEA AND ADJACENT REGIONS OF NORTH ATLANTIC Abstract Only** **c48**
P. Ye. Shirokov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 6 Transl. into ENGLISH from Izvestiya Vsesoyuznogo Geograficheskogo Obshchestva (Leningrad, USSR), v. 120, no. 3, May-Jun. 1988 p 265-269 (For primary document see N89-17907 10-42)
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Since it is important to evaluate the degree of consistency of long period variations of hydrometeorological characteristics in different energy active zones in the ocean (EAZO), a study was made of the qualitative uniformity and synchronous nature of climatic variability in the Norwegian EAZO and in adjacent areas of the Atlantic sector of the Northern Hemisphere. Significant correlations were found between the mean seasonal values of hydrometeorological characteristics (sea surface temperature, air temperature, velocity, resultant heat flow) registered at different weather ships, as well as the correlations of mean seasonal and mean annual values of hydrometeorological characteristics of weather ships. Significant asynchronous correlations were found for series of mean seasonal values of hydrometeorological parameters displaced relative to one another. The correlation coefficients between time space series in many cases are higher than between synchronous series. Author

**N89-17915#** Joint Publications Research Service, Arlington, VA.
**ANNULAR AND BLOCK-FOLDED STRUCTURES ON SPACE AND AERIAL PHOTOGRAPHS** **c43**
A. A. Bayramov, Kh. S. Mirzabekov, and A. Z. Abdullayev *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 7-8 Transl. into ENGLISH from Razvedka i Okhrana Nedr (Moscow, USSR), no. 6, Jun. 1988 p 17-20 (For primary document see N89-17907 10-42)
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The basin of the middle course of the Terter River, where the Kyzylbulakh ore field is located, is one of the regions in the Lesser Caucasus which has been studied in detail. According to the concepts of most researchers, the basin of the middle course of the Terter River is the point of joining of the Agdam anticlinorium and the northwestern part of the Martunin and Toragaychay synclinoriums. On the basis of geological observations and also a detailed study of space photographs and aerial photographs at different scales, a great many large fragments of Upper Jurassic limestones were detected, displaced in the direction of the Terter River floodplain, and thick alluvial-talus formations filling the Aterk accumulative basin. A study of the blocks and folded structures detected on the photographs shows that the first are a component part of the second. A block structure is expressed quite clearly in the Middle Jurassic formations, cut by longitudinal and transverse faults. Other structures are discussed in detail. Author

**N89-17916#** Joint Publications Research Service, Arlington, VA.
**ATTENUATION AND ABSORPTION OF RADIATION BY OPTICALLY SOFT CYLINDRICAL PARTICLES Abstract Only** **c46**
V. V. Kuznetsov and L. N. Pavlova *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 8 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery I Okeana (Moscow, USSR), v. 24, no. 2, Feb. 1988 p 205-211 (For primary document see N89-17907 10-42)
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There has been no precise solution of the problem of attenuation and scattering of radiation by aspherical particles of a finite size and arbitray configuration. Some approximate methods exist for particles with a refractive index close to 1, soft particles. In the case of soft particles the ray is almost not refracted and is not reflected by a particle. In solving this problem, the anomalous diffraction approximation is used in a study of attenuation and absorption of radiation by aspherical particles in the form of round and hexagonal cylinders. Expressions are also derived for computing the radiation attenuation and absorption efficiency factors for optically soft hexagonal prisms with an arbitrary orientation of their axis relative to the incident ray. It was found that the difference between a prism and round cylinder, and between particles of the same configuration but with different ratios of axes, is manifested most clearly for nonabsorbing particles. Definite relations were obtained for round and hexagonal cylinders for various conditions and parameters. Author

**N89-17917#** Joint Publications Research Service, Arlington, VA.
**USE OF STATISTICAL METHODS FOR PREDICTING HAIL PROCESSES AND THEIR CHARACTERISTICS Abstract Only** **c47**
L. M. Fedchenko and A. Kh. Kagermazov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 1 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 4, Apr. 1988 p 41-50 (For primary document see N89-17907 10-42)
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Long series of radiosonde data for several stations in the Northern Caucasus and related aerosynoptic information were used in computing parameters and discriminant functions for an alternative hail forecast. The algorithm and program for computing the parameters of the atmosphere and clouds developed on the basis of these data constitute an improved variant of the algorithm and program given earlier by Kh. Kh. Kalazhokov. Forty-five different thermodynamic and synoptic parameters of prognostic importance with respect to the physics of the considered phenomena were computed, as well as combined parameters used in preparing hail predictions by different methods. An evaluation of the parameters of hail processes is made using regression analysis, in whose implementation, in addition to thermodynamic parameters, use is made of those parameters reflecting the interaction between circulatory processes and relief in a region. The quality of predictions when using the described method is superior to the results obtained by the method now in use. Author

**N89-17918#** Joint Publications Research Service, Arlington, VA.
**REGIONAL MODEL OF ATMOSPHERIC TRANSPORT OF POLYDISPERSE ADMIXTURE Abstract Only** **c46**
V. A. Borzilov, N. A. Veltishcheva, N. V. Klepnikova, M. A. Novitskiy, A. L. Burkov, and L. M. Metelkina *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 9 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 4, Apr. 1988 p 57-65 (For primary document see N89-17907 10-42)
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A numerical model of regional transport of a polydisperse admixture from an instantaneous source is described. In order to improve spatial resolution, a finite difference equation was solved in a moving Euler grid. In solving the problem, allowance was made for spatial-temporal variability of the wind speed field and the field of turbulent diffusion coefficients. The parameterization of the atmospheric boundary layer is based on drag and heat exchange laws and also on the relations of similarity theory. Standard meteorological data were used as the input parameters for the atmospheric boundary layer model. The results of numerical experiments with modeling of transport and settling of an admixture on the underlying surface are outlined. A merit of the model is that in addition to the variability of large scale processes, it takes into account atmospheric boundary layer dynamics as a function of external parameters. Author

**N89-17919#** Joint Publications Research Service, Arlington, VA.
**JOINT MONITORING OF GEOPOTENTIAL AND TEMPERATURE USING LEVEL-2 FGGE DATA Abstract Only** **c47**
A. D. Naumov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 9-10 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 4, Apr. 1988 p 116-123 (For primary document see N89-17907 10-42)
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The results of multivariant checking of level IIb FGGE data obtained using the procedure of multivariant checking of aerological information used on an operational basis at the USSR Hydrometeorological Center are presented. Radiosonde communications from surface stations and ships received during the special FGGE period 21 to 28 Jan. 1979 are given particular attention. Data were obtained on the distribution of serious errors in geopotential and temperature at the main isobaric surfaces and in the principal geographical regions of the Northern Hemisphere. The generalized results of this checking at 10 standard levels are given. It was found that about 17 pct of the aerological telegrams contained no information on temperature at standard isobaric surfaces from 1000 to 100 gPa. The checking procedure makes it possible to fill in an approx. equal number of missing H and T values at the upper levels of the atmosphere 300 and 100 gPa and a considerably greater percentage of T values at the low levels 1000 and 850 gPa. Author

**N89-17920#** Joint Publications Research Service, Arlington, VA.
**ALBEDO OF SNOW, ICE AND WATER DETERMINED FROM OBSERVATIONAL DATA AND MODEL COMPUTATIONS Abstract Only** **c43**
K. Ya. Kondratyev, V. I. Korzov, and N. Ye TerMarkaryants, *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 10 Transl. into ENGLISH of Gidrometeorologiya. Seriya 37.21. Meteorologiya, Albedo Snega, LDA, i Vody po Dannym Nablyudeniy i Modelnykh Raschetov (Moscow, USSR), 1988 p 1-52 (For primary document see N89-17907 10-42)
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The albedo of snow, ice and water are examined on the basis of observational data and model computations. The importance of developmpent of methods for the parameterization of the albedo of snow, ice and water is demonstrated in relation to the development of numerical models of general circulation of the atmosphere and the theory of climate. Practical recommendations are given for computing the albedo of seas and estimates of snow-ice albedo feedback effects and data on the influence of albedo changes on climate are given. Author

**N89-17921#** Joint Publications Research Service, Arlington, VA.
**GEODETIC RESEARCH USING ARTIFICIAL EARTH SATELLITES Abstract Only** **c43**
N. Georgiyev and D. Zhekov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 10 Transl. into ENGLISH from Geodeziya i Kartografiya (Moscow, USSR), Apr. 1988 p 39-42 (For primary document see N89-17907 10-42)
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Research using artificial earth satellites has been carried out in Bulgaria since 1957. A review is presented of this research from 1957 to 1981. The beginning of space geodesy in Bulgaria began with the launching of the Intercosmos-Bolgarya satellite on 7 August 1981, which carried 11 space research instruments and the OLSS optical laser light-reflecting system, whose main purpose was laser sounding from surface observation stations. Theoretical and experimental research was carried out with the OLSS for finding an optimal design. During the first observation period alone, 74 visual, photographic and laser stations throughout the world participated in the observations. Immediately after launching, the laser reflector made it possible to make a more precise determination of the coordinates of surface stations and investigate the influence of the high atmosphere on the motion of such satellites. Author

**N89-17922#** Joint Publications Research Service, Arlington, VA.
**SOME RESULTS OF USE OF SPACE SURVEY MATERIALS IN CARTOGRAPHIC WORK Abstract Only** **c43**
Ye. A. Reshetov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 11 Transl. into ENGLISH from Geodeziya i Kartografiya (Moscow, USSR), no. 4, Apr. 1988 p 42-44 (For primary document see N89-17907 10-42)
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There are 4 principal areas in which space photographs and products of space surveys are used, each of which are reviewed: compilation and revision of topographic maps; compilation of topographic bases for various kinds of maps; mapping of natural resources; and specialized interpretation of photographs. Analytical phototriangulation, based on data on orbital motion of artificial earth satellites, was used in establishing a survey base over extensive territories inaccessible for aerial surveys or surface field work. Author

**N89-17923#** Joint Publications Research Service, Arlington, VA.
**FULL AND SELECTIVE INITIALIZATION IN SPECTRAL ATMOSPHERIC MODELS Abstract Only** **c46**
A. A. Ilin and A. N. Filatov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 11 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 3, Mar. 1988 p 5-16 (For primary document see N89-17907 10-42)
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In atmospheric spectral models, the eigenvalues of the spectrum of a linear model are broken down into two groups corresponding to the frequencies of gravity waves and Rossby waves. The initialization problem is solved as a problem in the choice of the initial field in such a way that the asymptotic expansion of the solution of the corresponding spectral model of the atmosphere does not contain rapidly oscillating terms. It is shown that in any finite time interval, initialization is always possible and rapid oscillations can be suppressed in any first N terms of an asymptotic expansion. Initialization in an infinite time interval and selective initialization are also discussed. Author

**N89-17924#** Joint Publications Research Service, Arlington, VA.
**INFLUENCE OF RADIATION REGIME CHANGES IN AIR TEMPERATURE AT LAND AND OCEAN SURFACE Abstract Only** **c47**
M. L. Asaturov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 11 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 3, Mar. 1988 p 17-28 (For primary document see N89-17907 10-42)
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In an earlier study, an energy balance model was proposed describing the seasonal changes in air temperature at the land and ocean surface and also different components of the Northern Hemisphere heat balance. It is shown, herein, that the model can

be used for evaluating changes in the Earth's thermal history after large releases of aerosol into the stratosphere which over a period of several months to several years can cause a considerable decrease in the quality of solar radiation reaching the Earth's surface. The properties of this model are investigated, followed by computations of air temperature changes at the land and ocean surface in the Northern Hemisphere. Author

**N89-17925#** Joint Publications Research Service, Arlington, VA.
**RESEARCH ON ICE-FORMING EFFICIENCY OF AgI AND PbI2 PYROTECHNIC NUCLEANTS IN STRATIFORM CLOUDS Abstract Only** **c47**
M. Ya. Aksenov, T. V. Bazzayev, B. N. Leskov, and N. O. Plaude *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 11-12 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 3, Mar. 1988 p 41-47 (For primary document see N89-17907 10-42)
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Small caliber (26 mm) pyrotechnic shells loaded with ice forming pyrotechnic AgI and PbI2 nucleants were tested in Ac, St and Sc clouds in experiments carried out from aircraft over two winter seasons. An industrial preparation containing 2 pct AgI and the earlier used 50 pct PbI2 preparation were tested in 24 paralleled experiments. The experiments were carried out at cloud layer temperatures from -9 to -29 C. It was found that a preparation with 2 pct AgI has a higher ice forming activity in the range of low supercoolings. The PbI2 preparation exhibits a lower temperature threshold of the effect, but with a decrease in cloud temperature, the effectiveness of the preparation increases rapidly and at temperatures below -20 C the crystallization zone which it generates has a greater width than the zone generated by a 2 pct AgI preparation when equal quantities of AgI and PbI2 are used. It is shown that the use of the new 2 pct AgI preparation is equally effective as the previously used 50 to 60 pct Pb2 and has a higher crystallizing activity in the important range of low cloud supercoolings. Author

**N89-17926#** Joint Publications Research Service, Arlington, VA.
**WATER TEMPERATURE CHANGE BELOW ACTIVE LAYER IN NORTH ATLANTIC OCEAN Abstract Only** **c48**
D. I. Antonov and P. Ya. Groysman *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 12 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 3, Mar. 1988 p 57-63 (For primary document see N89-17907 10-42)
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The full archives of bathometric observations for the period of instrumental observations was processed for evaluating changes in thermal structure at depths below 300 m in the North Atlantic and a comparison of these changes with observed global warming and cooling processes. The data were taken from the World Data Center, where data for 300,000 oceanographic stations are stored, but the only data used were for the 113,000 stations for which measurements at horizons below 300 m are available. Procedures were developed for eliminating the influence of the spatial variability of water temperature fields on the results of subsequent analysis by their transformation into temperature anomaly fields. A statistical analysis revealed statistically significant trends in change of mean water temperature at depths to 2000 m. It is postulated that these are attributable to the low frequency component of the global warming process transpiring in the lower layers of the atmosphere. The results indicated that the accumulated body of bathometric observations can be used for the study of large scale patterns of recent changes in the thermal regime of the deep ocean, the most inertial link in the climate system. Author

**N89-17927#** Joint Publications Research Service, Arlington, VA.
**SOUND RADIATION BY EDDIES, ACOUSTIC INSTABILITY AND ACOUSTIC COLLAPSE Abstract Only** **c71**
V. M. Gryanik *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 12 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery I Okeana (Moscow, USSR), v. 24, no. 5, May 1988 p 513-519 (For primary document see N89-17907 10-42)
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Sound is generated by nonstationary eddy movements in a compressible fluid. In exploring this phenomenon, a study was made of the influence of weak compressibility of a medium on evolution of localized eddy fields in systems with impaired translational invariance. Simple 2-D models are used in demonstrating that in such a system there may be acoustic instability and acoustic collapse caused by sound radiation by eddies. It is shown that free eddies can be drawn to fixed eddies if their vorticies are opposite in sign. A study was also made of the conditions under which free eddies are drawn to inhomogeneous rigid boundaries bounding the eddy current region. The necessary condition for collapse is the existence of such eddies opposite in sign; this requirement is also met by interaction of eddies of the same sign with a boundary. Some of the effects of acoustic instability and collapse are given. Author

**N89-17928#** Joint Publications Research Service, Arlington, VA.
**ACCURACY OF REFRACTOMETRIC METHOD IN HORIZONTALLY INHOMOGENEOUS ATMOSPHERE Abstract Only** **c46**
M. Ye. Gorbunov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 12-13 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery I Okeana (Moscow, USSR), v. 24, no. 5, May 1988 p 520-526 (For primary document see N89-17907 10-42)
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An algorithm for solving the inverse problem in atmospheric refraction was proposed earlier by the author. A continuation of this previous study is presented, with emphasis on the requirements imposed on the system for attaining a definite accuracy and resolution. The following factors limiting accuracy and resolution are examined in detail: interpolation errors, finite number of measurements; random measurement errors. Only horizontal resolution is taken into account. Sensitivity of the algorithm to interpolation errors was checked in a numerical experiment and the optimal grid interval was determined. A formula was derived for estimating limiting resolution and on this basis, a program was written for applying the full retrieval algorithm. Author

**N89-17929#** Joint Publications Research Service, Arlington, VA.
**COMPUTATION OF NONLINEAR ENERGY TRANSFER IN SPECTRUM OF WIND WAVES Abstract Only** **c48**
V. A. Kalmykov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 13 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 5, May 19888 p 95-102 (For primary document see N89-17907 10-42)
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Computations of the nonlinear transfer of wave energy are made on the basis of the kinetic equation for waves in deep water. The computations were made using model JONSWAP spectra and angular wave spectra narrower than used in earlier studies. It is shown that in this case wave energy is transferred from the region of the spectral maxima to the upper and lower frequencies, as was also found earlier. For narrow angular spectra, the energy transfer to the low frequencies decreases. A study was made of the interaction of two wave systems (swell and wind waves). Computations were made for three types of spectra, giving many results consistent with Masuda's work, but also revealing earlier unknown facts. For example, when the spectrum contains two systems of waves with different directions of movement, not differing very greatly from one another, energy transfer is from wind waves to swell, not vice versa, as might be expected.
Author

# 43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

**N89-17930** Missouri Univ., Columbia.
**SATELLITE DERIVED EARTH SURFACE TEMPERATURES: A CROP ASSESSMENT TOOL Ph.D. Thesis**
Christy Lynn Crosiar 1987 144 p
Avail: Univ. Microfilms Order No. DA8818929

The data for this research consist of the following: 23 days of NOAA/AVHRR satellite data; AgRISTARS enumerator data (or ground truth data) for 26 counties in three midwestern states and radiosonde observations for nine upper air stations, producing an 8 state coverage. The objectives of this research are threefold: (1) to develop a regression model to estimate maximum shelter temperature, (2) to develop a method to assess crop conditions and (3) to determine the variability within a scan line due to changes in optical depth and/or scan angle. The results from this research is given and discussed. Dissert. Abstr.

**N89-17931#** South Carolina Univ., Columbia. Dept. of Geography.
**THE DERIVATION AND VERIFICATION OF SURFACE REFLECTANCES USING AIRBORNE MSS DATA AND A RADIATIVE TRANSFER MODEL**
Elijah W. Ramsey, III and John R. Jensen 1988 17 p Presented at the Fall Technical Meeting of the American Society of Photogrammetry and Remote Sensing, Virginia Beach, VA, 11 Sep. 1988
(Contract DE-AC09-76SR-00001)
(DE89-004881; DP-MS-88-153; CONF-8809220-2) Avail: NTIS HC A03/MF A01

Surface reflectance images were derived from airborne MSS data using a radiative transfer model to eliminate atmospheric effects and to derive downwelling irradiances. Input radiative transfer model parameters and Brightness Value (BV) to radiance conversion gain and bias factors were generated for each band using an optimization procedure to minimize the difference between modelled and image BV. Subsequently, reflectance images were derived at five wavelengths from the blue to red bands using the optimized parameters as inputs into the radiative transfer model. Modelled surface reflectance images were evaluated for accuracy by statistical comparison to measured reflectances, and for improved contrast by subjective comparison to the original images. Daedalus DS-1260 MSS bands 3, 4 and 5 modelled reflectances explained 25, 75 and 72 percent of the measured reflectance variances, respectively; while bands 2 and 7 correlation were not significant (p less than .05). Finally, the generated reflectance images showed dramatic improvement in contrast, revealing textures that were not apparent in the original images. DOE

**N89-17932#** South Carolina Univ., Columbia. Dept. of Geography.
**A COMPARISON OF ORIGINAL AIRCRAFT MSS AND GENERATED SURFACE WATER REFLECTANCE IMAGES AS PREDICTORS OF LAKE WATER QUALITY INDICATORS**
Elijah W. Ramsey, III and John R. Jensen 1988 13 p Presented at the Fall Technical Meeting of the American Society of Photogrammetry and Remote Sensing, Virginia Beach, VA, 11 Sep. 1988
(Contract DE-AC09-76SR-00001)
(DE89-004882; DP-MS-88-152; CONF-8809220-1) Avail: NTIS HC A03/MF A01

Generated reflectance and original MSS images were compared at six blue to near infrared wavelengths at thirty-eight (38) field locations in three different lakes. Both sets of images were evaluated in terms of their importance in explaining the variance of measured reflectances. Subsequently, the generated reflectance images were related to measured chlorophyll a and total suspended solids using a statistical analysis that uncovered the simplest relationships explaining the greatest amount of each water variables variance. Applying this methodology resulted in predictor equations explaining 82 percent of the chlorophyll a variance and 92 percent of the total suspended solids variance within the thirty-two (32) water samples analyzed. Maps were produced of L Lake depicting the distributions of two water quality indicators: chlorophyll a and total suspended particles. DOE

**N89-17933#** Harvard Coll. Observatory, Cambridge, MA.
**RESEARCH IN GEODESY AND GEOPHYSICS BASED UPON RADIO INTERFEROMETRIC OBSERVATIONS OF EXTRAGALACTIC RADIO SOURCES Final Report, 3 Apr. 1986 - 15 Jun. 1988**
T. A. Herring 1 Oct. 1988 80 p
(Contract F19628-86-K-0025)
(AD-A200958; AFGL-TR-88-0204) Avail: NTIS HC A05/MF A01 CSCL 08E

Data is used from the Mark 3 Very-Long-Baseline Interferometry (VLBI) system to study the relative motions of radiotelescopes on the Pacific, North American, and Eurasian plates, and in the deformation zone between the North American and Pacific plates in the California region. These results are in accord with recent geologic plate motion models, and a distributed deformation zone between the North American and Pacific plates. We have carried out a number of studies on the accuracy of the results being obtained with VLBI. The most notable of these studies are of the repeatability of the estimates of 3-D coordinates of the sites for long baselines (approx. 4,000 km), and the effects of calibrations of the wet tropospheric delays using water-vapor radiometers. We have also been studying the usefulness of observations made at very low elevation angles (approx. 4 deg.) for improving the accuracy of VLBI baseline determinations. We have also studied the forced nutations of the Earth which yielded results consistent with the flattening of the core-mantle boundary being about 5 percent greater than that prodicted by the assumption of hydrostatic equilibrium within the Earth. The effects of ocean tides and the anelasticity of the mantle on the the forced nutations are not clearly evident in the results, and are still being investigated. GRA

**N89-17934#** Naval Postgraduate School, Monterey, CA.
**THREE ALGORITHMS FOR PLANAR-PATCH TERRAIN MODELING M.S. Thesis**
Seunghee Yee Jun. 1988 101 p
(AD-A200973) Avail: NTIS HC A06/MF A01 CSCL 12E

Providing a simplified model of real terrain has applications to route planning for robotic vehicles and military maneuvers. This thesis explores planar-patch surface modeling to represent terrain in a simple and effective way. In planar-patch surface modeling the terrain is subdivided into a set of planar subregions. The homogeneity of the gradient within a planar subregion simplifies calculating the cost of traversing the region, thus simplifying route planning. The author has explored three main strategies to model the surface: joint top-down and bottom-up, strict bottom-up, and presmoothing bottom-up approaches. Results of the algorithms are shown graphically by using the APL and Grafstat packages, verifying their correctness and accuracy. GRA

**N89-17935#** Institut fuer Angewandte Geodaesie, Frankfurt am Main (Germany, F.R.).
**REPORTS ON CARTOGRAPHY AND GEODESY, SERIES 1, NUMBER 100 [NACHRICHTEN AUS DEM KARTEN- UND VERMESSUNGSWESEN, REIHE 1, HEFT NR. 100]**
1988 86 p In GERMAN; ENGLISH summary
(ISSN-0469-4236; ETN-89-93778) Avail: NTIS HC A05/MF A01

The proximity relations between spatially distributed points in a three-dimensional lattice were established using raster data processing. A digital terrain model was created using triangulation in the raster. A basis for the optimal visual perception of television weather forecast maps was established. A system for the

automated construction of panoramic views from digital terrain models was developed. For individual titles, see N89-17936 through N89-17939.

**N89-17936#** Institut fuer Angewandte Geodaesie, Frankfurt am Main (Germany, F.R.).
**DETERMINATION OF PROXIMITY RELATIONS OF POINTS IN THREE DIMENSIONAL SPACE USING RASTER DATA PROCESSING [DIE BESTIMMUNG DER NACHBARSCHAFTSRELATIONEN VON PUNKTEN IN DREIDIMENSIONALEN RAUM MIT HILFE DER RASTERDATENVERARBEITUNG]** **c64**
Hans-Joerg Gottschalk *In its* Reports on Cartography and Geodesy, Series 1, Number 100 1988 p 5-20 In GERMAN; ENGLISH summary (For primary document see N89-17935 10-43)
Avail: NTIS HC A05/MF A01

The proximity relations between spatially distributed points using distance transforms in a space lattice were established. Distance transforms, Thiessen polygons, and algorithms for the calculation of distance transforms are introduced. The algorithms for the calculation of distance transforms in a three-dimensional lattice allow the determination of proximity relations between points in this lattice. These relations are used to decide which points are adjacent and which are not. ESA

**N89-17937#** Institut fuer Angewandte Geodaesie, Frankfurt am Main (Germany, F.R.).
**CONSTRUCTION OF A DIGITAL TERRAIN MODEL USING TRIANGULATION IN THE RASTER [DIE KONSTRUKTION EINES DIGITALEN GELAENDEMODELLS MIT HILFE DER TRIANGULTION IM RASTER]**
Hans-Joerg Gottschalk *In its* Reports on Cartography and Geodesy, Series 1, Number 100 1988 p 21-30 In GERMAN; ENGLISH summary (For primary document see N89-17935 10-43)
Avail: NTIS HC A05/MF A01

A digital terrain model was created by triangulating accumulations of points using local operations in the raster. The distance transform for a combination of a four and an eight metric was used to determine Thiessen polygons. The triangulation network was derived from the proximity relations of the Thiessen polygons. With this method, linear objects such as fault scarp edges and contours can be processed in one operation together with the single points. ESA

**N89-17938#** Institut fuer Angewandte Geodaesie, Frankfurt am Main (Germany, F.R.).
**VISUAL PERCEPTION OF TELEVISION WEATHER FORECAST MAPS [VISUELLE WAHRNEHMUNG VON FERNSEH-WETTERKARTEN]** **c47**
Rene Sieber *In its* Reports on Cartography and Geodesy, Series 1, Number 100 1988 p 31-48 In GERMAN; ENGLISH summary (For primary document see N89-17935 10-43)
Avail: NTIS HC A05/MF A01

A basis for the optimal design of maps and for the determination of map and viewer relevant variables was established using a thematic weather forecast map. The theoretical fundamentals of decision making and the methods to establish and assess relevant factors of visual perception are given. The complexity of the weather maps proved to be an essential controllable factor, while the exposure time turned out to be unimportant. Concerning viewer oriented variables, sex and interest in maps influence the efficiency of perception. ESA

**N89-17939#** Institut fuer Angewandte Geodaesie, Frankfurt am Main (Germany, F.R.).
**AUTOMATIC CONSTRUCTION OF PANORAMIC VIEWS FROM DIGITAL TERRAIN MODELS [AUTOMATISCHE KONSTRUKTION PANORAMISCHER ANSICHTEN AUS DIGITALEN GELAENDEMODELLEN]**
Robert Weibel and Adrian Herzog *In its* Reports on Cartography and Geodesy, Series 1, Number 100 1988 p 49-84 In GERMAN; ENGLISH summary (For primary document see N89-17935 10-43)
(Contract SNFwF-2.082-0.86)
Avail: NTIS HC A05/MF A01

A system for the automated construction of panoramic views from digital terrain models was developed. The major features of this system are a choice between types of surface symbolization and a flexible projection concept which makes it possible to use the most distinct types of projection. The automated panorama construction includes selection of an observation point; compensation of Earth curvature and refraction; visibility determination including transformation of the x,y,z coordinates into a system of geographic coordinates; projection of visible elements using common map projections; and display. The algorithmic aspects of panorama construction are discussed. An extension of the basic panorama constructions by overlay of additional information (point, line and areal features, name placement) is presented. ESA

**N89-17910#** Joint Publications Research Service, Arlington, VA.
**PRINCIPAL PROBLEMS IN UPGRADING QUALITY AND EFFICIENCY OF GEOLOGICAL SURVEY WORK Abstract Only**
D. S. Bulayevskiy, V. A. Velikanov, D. F. Volodin, A. S. Drannik, V. N. Solovitskiy, and A. A. Frayberger *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 2 Transl. into ENGLISH from Geologicheskiy Zhurnal (Kiev, USSR), no. 2, Feb. 1988 p 3-12 (For primary document see N89-17907 10-42)
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**N89-17915#** Joint Publications Research Service, Arlington, VA.
**ANNULAR AND BLOCK-FOLDED STRUCTURES ON SPACE AND AERIAL PHOTOGRAPHS**
A. A. Bayramov, Kh. S. Mirzabekov, and A. Z. Abdullayev *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 7-8 Transl. into ENGLISH from Razvedka i Okhrana Nedr (Moscow, USSR), no. 6, Jun. 1988 p 17-20 (For primary document see N89-17907 10-42)
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**N89-17920#** Joint Publications Research Service, Arlington, VA.
**ALBEDO OF SNOW, ICE AND WATER DETERMINED FROM OBSERVATIONAL DATA AND MODEL COMPUTATIONS Abstract Only**
K. Ya. Kondratyev, V. I. Korzov, and N. Ye TerMarkaryants, *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 10 Transl. into ENGLISH of Gidrometeorologiya. Seriya 37.21. Meteorologiya, Albedo Snega, LDA, i Vody po Dannym Nablyudeniy i Modelnykh Raschetov (Moscow, USSR), 1988 p 1-52 (For primary document see N89-17907 10-42)
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**N89-17921#** Joint Publications Research Service, Arlington, VA.
**GEODETIC RESEARCH USING ARTIFICIAL EARTH SATELLITES Abstract Only**
N. Georgiyev and D. Zhekov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 10 Transl. into ENGLISH from Geodeziya i Kartografiya (Moscow, USSR), Apr. 1988 p 39-42 (For primary document see N89-17907 10-42)
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**N89-17922#** Joint Publications Research Service, Arlington, VA.
**SOME RESULTS OF USE OF SPACE SURVEY MATERIALS IN CARTOGRAPHIC WORK Abstract Only**
Ye. A. Reshetov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 11 Transl. into ENGLISH from Geodeziya i Kartografiya (Moscow, USSR), no. 4, Apr. 1988 p 42-44 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

# 44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

**N89-17940#** Sandia National Labs., Albuquerque, NM. Photovoltaic Cell Research Div.

**THE STATUS AND PROSPECTS OF HIGH-EFFICIENCY SOLAR CELLS**

Paul A. Basore 1988 12 p Presented at the 8th New Energy Industrial Symposium, Tokyo, Japan, 20 Oct. 1988

(Contract DE-AC04-76DP-00789)

(DE89-001818; SAND-88-2549C; CONF-8810199-1) Avail: NTIS HC A03/MF A01

It appears likely that laboratory demonstration of flat-plate modules with 18 percent efficiency using potentially cost-effective materials and processing will occur in the next 18 months. The initial prototype modules will probably use wafers that have been thinned down from thick starting material. The major remaining technical obstacle will be the mass production and handling of thin material with high yield, be it in the form of thin wafers or thin silicon layers grown on a low-cost substrate. Thin wafers could be obtained directly using sheet-growth techniques, or could be cut from ingots if new slicing technology is developed. Growth on a low-cost substrate makes it easier to process the material without breakage, but also blocks access to the back surface of the cell, making it difficult to obtain the necessary surface passivation at the interface. Within the United States photovoltaic program, the developments described are most likely to occur in the universities, particularly Stanford and the University of New South Wales; or at the national laboratories, particularly Sandia. The subsequent challenge to achieving widespread adoption of the high-efficiency approach will be to successfully transfer the necessary understanding to the photovoltaic industry along with enough proprietary advantage to create a profit. DOE

**N89-17941*#** Space Power, Inc., San Jose, CA.

**MEGAWATT CLASS NUCLEAR SPACE POWER SYSTEMS (MCNSPS) CONCEPTUAL DESIGN AND EVALUATION REPORT. VOLUME 1: OBJECTIVES, SUMMARY RESULTS AND INTRODUCTION Final Report**

J. R. Wetch et al Sep. 1988 40 p Sponsored in part by DOD, Washington, DC and DOE, Washington, DC

(Contract NAS3-23867)

(NASA-CR-179614-Vol-1; NAS 1.26:179614-Vol-1; SPI-25-1) Avail: NTIS HC A03/MF A01 CSCL 10B

The objective was to determine which reactor, conversion, and radiator technologies would best fulfill future Megawatt Class Nuclear Space Power System Requirements. Specifically, the requirement was 10 megawatts for 5 years of full power operation and 10 years systems life on orbit. A variety of liquid metal and gas cooled reactors, static and dynamic conversion systems, and passive and dynamic radiators were considered. Four concepts were selected for more detailed study. The concepts are: a gas cooled reactor with closed cycle Brayton turbine-alternator conversion with heat pipe and pumped tube-fin heat rejection; a lithium cooled reactor with a free piston Stirling engine-linear alternator and a pumped tube-fin radiator; a lithium cooled reactor with potassium Rankine turbine-alternator and heat pipe radiator; and a lithium cooled incore thermionic static conversion reactor with a heat pipe radiator. The systems recommended for further development to meet a 10 megawatt long life requirement are the lithium cooled reactor with the K-Rankine conversion and heat pipe radiator, and the lithium cooled incore thermionic reactor with heat pipe radiator. Author

**N89-17942#** Midwest Research Inst., Golden, CO. Solar Energy Research Inst.

**PREDICTION OF STOCHASTIC BLADE RESPONSES USING A FILTERED NOISE TURBULENCE MODEL IN THE FLAP (FORCE AND LOADS ANALYSIS PROGRAM) CODE**

R. W. Thresher, W. E. Holley, and A. D. Wright Nov. 1988 11 p Presented at the ASME Energy-Sources Technology Conference and Exhibition and 7th Intersociety Cryogenic Symposium, Houston, TX, 22 Jan. 1989

(Contract DE-AC02-83CH-10093)

(DE89-000835; SERI/TP-217-3413; CONF-890102-13) Avail: NTIS HC A03/MF A01

Accurately predicting wind turbine blade loads and resulting stresses is important for predicting the fatigue life of components. There is a clear need within the wind industry for validated codes that can predict not only the deterministic loads from the mean wind velocity, wind shear, and gravity, but also the stochastic loads from turbulent inflow. The FLAP code has already been validated for predicting deterministic loads. This paper concentrates on validating the FLAP code for predicting stochastic turbulence loads using the filtered-noise turbulence model as input. DOE

**N89-17943#** Midwest Research Inst., Golden, CO. Solar Energy Research Inst.

**HYDRODYNAMIC, THERMAL AND RADIATIVE TRANSFER BEHAVIOR OF MOLTEN SALT FILMS AS APPLIED TO THE DIRECT ABSORPTION RECEIVER CONCEPT**

H. J. Green, M. S. Bohn, and M. Carasso Oct. 1988 22 p Presented at the 4th International Symposium on Research, Development and Applications of Solar Thermal Technology, Santa Fe, NM, 13 Jun. 1988

(Contract DE-AC02-83CH-10093)

(DE89-000819; SERI/TP-253-3412; CONF-880655-8) Avail: NTIS HC A03/MF A01

The direct absorption receiver (DAR) is a solar thermal central receiver concept that, in contrast to state-of-the-art tubular receivers, directly exposes a flow of the working fluid to concentrated solar flux. Recent research indicates that using molten salts as the working fluid is technically feasible and economically beneficial. The molten salt flows down a near-vertical support surface and is exposed to the direct solar flux concentrated by a field of heliostats. DOE

**N89-17944#** Spire Corp., Bedford, MA.

**CONTINUED DEVELOPMENT OF METALLIZATION FOR GaAs CONCENTRATOR CELLS**

Stephen P. Tobin Nov. 1988 126 p

(Contracts DE-AC04-76DP-00789; Sandia-04-6098)

(DE89-005491; SAND-88-7033) Avail: NTIS HC A07/MF A01

The objective of this work was the integration of thermally stable metallizations with a high-efficiency GaAs concentrator cell process. For p-GaAs we used a Pt-TiN-Au metallization developed under a previous Sandia contract. For n-GaAs the best results were obtained for AuGe-TiN-Au. Baseline p/n cells with a CrAu metallization achieved efficiencies of 25.4 percent at 200 suns. Efficiencies were about 22 percent at one sun. At one sun, p/n cells with high-temperature contacts were 22.2 percent efficient, showing that there is no efficiency penalty with the high-temperature metallization. Development efforts on n/p cells yielded high short-circuit currents and open-circuit voltages, with both conventional and high-temperature metallizations. Thermal annealing tests showed that cells with the Pt-TiN-Au metallization were more stable than those with the baseline metallization, withstanding a 15-minute anneal at 500 C with negligible efficiency degradation. DOE

**N89-17945#** Pacific Northwest Labs., Richland, WA.

**ESTIMATION OF TURBULENCE LEVEL AND SCALE FOR WIND TURBINE APPLICATIONS**

D. C. Powell Nov. 1988 81 p

(Contract DE-AC06-76RL-01830)

(DE89-005509; PNL-6753) Avail: NTIS HC A05/MF A01

A simplified method is presented for estimating onsite

turbulence variance within the wind turbine layer for horizontal wind speed. The method is based principally on estimating the probability distribution of wind speed and assigning a variance to each mean wind speed based on surface roughness estimates. The model is not proposed as an alternative to onsite measurement and analysis, but rather as an adjunct to such a program. A revision of the Kaimal neutral u-component spectrum is suggested to apply to the mix of the stabilities occurring during operational winds. Values of integral length scale calculated from data analysis are shown to contradict the length scale model implicit in turbulence power spectra. Also, these calculated values are shown to be extremely sensitive to the length of the time series and the detrending method used. The analysis and modeling are extended to the rotational frame of reference for a horizontal-axis wind turbine by modeling the ratios of harmonic spike variances (1P, 2P, etc.) in the rotational spectrum to the Eulerian turbulence variance. DOE

**N89-17946*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**DIRECT CONVERSION TECHNOLOGY Annual Summary Report**
P. F. Massier, C. P. Bankston, G. Fabris, and L. D. Kirol 1 Dec. 1988 68 p
(Contract DE-AI01-86CE-90237)
(NASA-CR-183285; NAS 1.26:183285; DE89-003911; JPL-D-5698) Avail: NTIS HC A04/MF A01 CSCL 10A

The overall objective of the Direct Conversion Technology task is to develop an experimentally verified technology base for promising direct thermal-to-electric energy conversion systems that have potential application for energy conservation in the end-use sectors. This report contains progress of research on the Alkali Metal Thermal-to-Electric Converter (AMTEC), and on the Two-Phase Liquid-Metal MHD Electrical Generator (LMMHD) for the period January 1988 through December 1988. Research on these concepts was initiated during October 1987. In addition, status reviews and assessments are presented for thermomagnetic converter concepts and for thermoelastic converters (Nitinol heat engines). Reports prepared on previous occasions contain discussions on the following other direct conversion concepts: thermoelectric, pyroelectric, thermionic thermophotovoltaic and thermoacoustic; and also, more complete discussions of AMTEC and LMMHD systems. A tabulated summary of the various systems which have been reviewed thus far has been prepared. Some of the important technical research needs are listed and a schematic of each system is shown. DOE

**N89-17947#** Institute for Defense Analyses, Alexandria, VA.
**EVALUATION OF POTENTIAL MILITARY APPLICATIONS OF STIRLING ENGINES Final Report, Jan. - Jun. 1988**
Ivan C. Oelrich and Frederick R. Riddell Jul. 1988 89 p
(Contract MDA903-84-C-0031)
(AD-A201000; AD-E501032; IDA-P-2118; IDA/HQ-88-33445) Avail: NTIS HC A05/MF A01 CSCL 20M

This paper reports on the potential military applications of the Stirling engine. In the applications considered here, the major advantages cited for the Stirling engine are multifuel capability, efficiency, and low noise levels. These potential advantages are small compared to current diesels. Diesels are already able to burn broadcut fuels, have high efficiency, and can be adequately muffled. Their major disadvantages are size, weight, and cost. These disadvantages are only severe in vehicular and mobile power applications where the competition is open-cycle internal combustion engines (diesel, spark-ignition, or turbine). In underwater and space power applications where closed-cycle engines are a necessity, the use of Stirling engines shows more promise. GRA

**N89-17948#** Idaho National Engineering Lab., Idaho Falls.
**STATUS AND TRENDS OF GEOTHERMAL DIRECT USE PROJECTS IN THE UNITED STATES**
Ben C. Lunis and Paul J. Lienau (Oregon Inst. of Tech., Klamath Falls.) 1988 5 p Presented at the Annual Meeting of the Geothermal Resources Council, San Diego, CA, 9 Oct. 1988
(Contract DE-AC07-76ID-01570)
(DE89-005417; EGG-M-88421; CONF-881045-6) Avail: NTIS HC A02/MF A01

The United States is continuing to experience a significant growth rate in the use of low- and moderate-temperature geothermal resources for direct use applications, which is making an increasing contribution to the United States energy demands. This paper provides an overview of how and where geothermal energy is being used, the extent of that use, and what the development trends and concerns appear to be. The applications discussed include industrial processes, heat pumps (heating and cooling), pools and spas, aquaculture and agriculture applications, and space and district heating projects. DOE

**N89-17949#** Sandia National Labs., Livermore, CA.
**A DESCRIPTION AND ASSESSMENT OF HELIOSTAT TECHNOLOGY**
C. L. Mavis Jan. 1989 182 p
(Contract DE-AC04-76DR-00789)
(DE89-006001; SAND-87-8025) Avail: NTIS HC A09/MF A01

This report summarizes heliostat development through 1986 by the Department of Energy's Solar Thermal Central Receiver Program. It has been prepared to provide potential users and developers of Central Receiver Systems with an assessment and overview of the technology. The topics covered are design descriptions, cost information, operation, maintenance, reliability, cleaning, beam safety, evaluation instrumentation, materials, and future research and development recommendations. DOE

# 45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

**N89-17950** State Univ. of New York, Stony Brook.
**CHLORINE MONOXIDE IN THE ANTARCTIC SPRING STRATOSPHERE Ph.D. Thesis**
Mauricio Jaramillo-Ayerbe 1988 133 p
Avail: Univ. Microfilms Order No. DA8815785

A series of observations of stratospheric chlorine monoxide (ClO) were carried out during the austral springs of 1986 and '87, as part of two experimental campaigns sent to investigate the seasonal decrease in ozone over the antarctic continent. Measurements of the vertical distribution of ClO were obtained by high resolution ground based emission spectroscopy at 278 GHz, using a mm-wave receiver. They show the presence of an anomalous layer of lower stratospheric ClO which is not observed at other latitudes. This anomalous layer is centered at approx. 20 km altitude and exhibits a pronounced diurnal variation, reaching a maximum at midday and disappearing at night. During the period of 20 to 24 Sep. 1987, the lower stratospheric ClO had a maximum volume mixing ratio of + or - 0.5 to 0.9 ppbv. A normal ClO layer centered at 36 km was also observed, with concentrations and diurnal behavior similar to those seen in tropical latitudes. These findings are evidence of anomalous chlorine chemistry taking place in the lower stratosphere during the antarctic spring, and indicate that increasing anthropogenic chlorine is a prime causative agent in the formation of the ozone hole. Dissert. Abstr.

**N89-17951#** Brookhaven National Lab., Upton, NY. Environmental Chemistry Div.
**REACTIVE SCAVENGING IN CLOUDS**
Peter H. Daum Oct. 1988 3 p Presented at the Symposium on the Role of Clouds in Atmospheric Chemistry and Global Climate, Anaheim, CA, 29 Jan. - 3 Feb. 1989 Submitted for publication
(Contract DE-AC02-76CH-00016)
(DE89-004535; BNL-41951; CONF-890134-2) Avail: NTIS HC A02/MF A01

Since field evidence suggests rapid and quantitative in-cloud oxidation of SO2 to SO4 to the extent limited by the availability of

H2O2, it is important to assess H2O2 and SO2 concentration fields under pertinent sets of conditions. We discuss here the concentrations of these and related species measured during the PRECP-V field program conducted in Central Ohio during June, 1987. These measurements document the concentration fields of these two species under midwestern summertime conditions, and extends examination of SO2/H2O2 relationships to clear-air conditions. DOE

**N89-17952#** Fraunhofer Inst. fuer Physikalische Messtechnik, Freiburg (Germany, F.R.).
**QUANTITATIVE ANALYSIS OF ATMOSPHERIC TRACE GASES Final Report, 1 Apr. 1983 - 31 Mar. 1988 [QUANTITATIVE ANALYSE VON ATMOSPHAERISCHEN SPURENGASEN]**
G. Schmidtke, W. Kohn, U. Klocke, M. Knothe, W. J. Riedel, and H. Wolf 24 Apr. 1988 119 p In GERMAN
(Contract BMFT-423-4007-0704569-8)
(Rept-09/1988; ETN-89-93517) Avail: NTIS HC A06/MF A01

A fully automatic diode laser spectrometer was developed and tested for the measurements of concentrations the trace gases NO, NO2, HNO3, O3, and SO2 in the ppb and sub-ppb range. The experimental setup has a modular design and microprocessor control. A White cell, diffraction limited mirror optics, and astigmatism corrected cuvettes were developed. The determination of the gas concentration is based on the measurement of the extinction of the signal integrated over the absorption line profile (integrative spectroscopy). The measuring sensitivities are as good as 50 ppt and the focusing quality is very good. Further improvements are expected from a better cooling system. ESA

**N89-17953#** Oak Ridge National Lab., TN. Environmental Science Div.
**ACCESSIBILITY AND VERIFICATION OF CO2 EMISSION ESTIMATES**
T. A. Boden, S. F. Huang, P. Kanciruk, and T. R. Nelson 1988 16 p Presented at the 2nd Joint Conference on Integrating Data for Decision Making, Washington, DC, 12 Dec. 1988
(Contract DE-AC05-84OR-21400)
(DE89-004179; CONF-881245-1) Avail: NTIS HC A03/MF A01

The Department of Energy's Carbon Dioxide Information Analysis Center (CDIAC) provides CO2-related data in the form of numeric data packages (NDPs) to researchers and policymakers. During compilation of these NDPs, CDIAC thoroughly checks the data and interacts with the contributing researchers and agencies to ensure greater understanding and proper interpretation of the data. During the compilation of a recent NDP, CDIAC collaborated with the United Nations (UN) Energy Statistics Unit to ensure the quality of the UN Energy Data Base. This data base, with more than 310,000 records and 2,000,000 data values, consists of detailed energy production and consumption estimates for all countries from 1950 to 1986. It is essential to the CO2 research program to estimate and predict CO2 emission rates. The resulting data base developed by CDIAC containing global and national CO2 emission estimates shows that the amount of CO2 produced globally from fossil fuel burning and cement manufacturing has risen significantly since 1950. The 1986 global emission estimate of 5.5 gigatons of carbon represents a 4.1 percent increase over the rate in 1985. DOE

**N89-17954#** Ohio State Univ., Columbus.
**HYDROLOGICAL AND GEOCHEMICAL RESPONSE AND RECOVERY IN DISTURBED ARCTIC ECOSYSTEMS**
K. R. Everett 1988 52 p
(Contract DE-FG02-84ER-60246)
(DE89-004678; DOE/ER-60246/T1) Avail: NTIS HC A03/MF A01

The investigations proposed in the following pages fall into three general categories. First, maintenance in Phase 2 of hydrogeochemical and hydrological data base begun in the Imnavait Creek watershed in 1985. These data were collected to answer questions concerning the ionic composition of precipitation considered to be the principal, if not the only, source of input. The second category of investigations proposed as part of the conceptual framework put forth for Phase 2 of the R4D program constitute new directions of research that build on those of Phase 1. For example, it has become clear that the watershed of Imnavait Creek and those of its water track sub-basin do not contribute uniformly to either the discharge of the stream or to its ionic water flow across the different slope elements. Thus it is necessary to experimentally study subsurface solute movement and develop transport models that incorporate the physical and chemical characteristics of the soils. This includes the spatial or map distribution of soil types and accompanying vegetation to completely portray soil-soil solution vegetation interactions on the continuum of slope elements. It also appears that major ionic inbalances in surface water budgets are tied to the dissolved organic component both of the soil water and surface water. DOE

**N89-17955#** Lawrence Livermore National Lab., CA.
**DATA STRUCTURE AND MEMORY MANAGEMENT IN THE NCAR/LLNL COMMUNITY CLIMATE MODEL (CCM1L)**
Charles OConnor and Curt Covey Dec. 1988 45 p
(Contract W-7405-eng-48)
(DE89-004986; UCID-21601) Avail: NTIS HC A03/MF A01

Extensive modifications of the Community Climate Model Version 1 (CCM1) were required, after this computer code was imported from the National Center for Atmospheric Research, to enable efficient execution in the computing environment of the Lawrence Livermore National Laboratory. Most of the modifications involved storage and transfer of large data sets as the model executes. The management of these data sets was generalized to permit users to select among a variety of fast storage media/internal memory, solid state storage devices, or disk -- depending on their availability and their suitability for optimum performance on present and future supercomputer systems. We describe these additions to the CCM1 code and related modifications to its data files. In the optimum configuration of the LLNL version of CCM1, the code is run on a Cray XMP computer with attached Solid-State Storage Device; working files are maintained in internal memory or the SSD, while input and output files are buffered from and to disk. This procedure results in a great reduction in input/output overhead. DOE

**N89-17956#** Sheladia Associates, Inc., Rockville, MD.
**CANADIAN SO2 AND NO(SUB x) EMISSIONS STUDY Final Report**
May 1988 43 p
(Contract DE-AC01-84FE-60457)
(DE89-005570; DOE/FE-60457/T1) Avail: NTIS HC A03/MF A01

The purpose of this report is to examine historic Canadian SO2 and NO sub x emissions trends and emission reduction efforts, current air quality reductions, and future energy needs. Canadian emissions data for 1970 through 1984 were used as the basis for most of the analyses that follow, as they were readily available and this time frame is most relevant to the current acid rain debate. This report is divided into five sections. The first section of the Executive Summary, which presents the report's findings on a point-by-point basis. The second section describes Canadian emissions inventories and emissions estimating methodologies. The third section looks at the sectoral and provincial SO2 and NO sub x emissions trends. Canada's air quality programs are addressed in the fourth section. The last section considers Canada's energy outlook, and the implications for future coal consumption especially as a component of Canada's projected electrical generating requirements. DOE

**N89-17957#** Oak Ridge National Lab., TN. Environmental Sciences Div.
**ENVIRONMENTAL CONSEQUENCES OF CO2-CLIMATE INTERACTIONS: THE NEED FOR INTEGRATED RESOURCE ANALYSIS**
Robert M. Cushman, Joyce C. Waterhouse, and Michael P. Farrell Jan. 1989 20 p

(Contract DE-AC05-84OR-21400)
(DE89-005707; ORNL/CDIAC-28) Avail: NTIS HC A03/MF A01

The increasing concentration of atmospheric carbon dioxide is expected to alter the global climate, and thereby affect agriculture, forestry, fisheries, and water resources. Resources such as these interact on a regional scale, and realistic projections of the effects on these resources must take into account the important interactions and feedbacks linking them. In addition, carbon dioxide directly affects the water use and growth of vegetation; therefore, the interactive effects of carbon dioxide and climate must also be considered. These interactions and feedbacks pose a significant challenge to any attempt to model the response of resources to changing carbon dioxide and climate. In particular, model linkage and the integration of processes that operate on different spatial and temporal scales are problems that must be addressed. DOE

# 46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

**N89-17958** Wisconsin Univ., Madison.
**ATMOSPHERIC ENERGETICS IN ISENTROPIC COORDINATES Ph.D. Thesis**
Michiko Masutani 1987 179 p
Avail. Univ. Microfilms Order No. DA8800725

The part of total potential energy (TPE) that interacts with kinetic energy is called available potential energy (APE). The theory of APE was used extensively to study the maintenance of atmospheric circulation. In the diagnostic studies, the approximate form of APE in isobaric coordinates was most commonly used to estimate APE. In this study, the complete form of APE without any approximations is introduced. Then using the complete form of TPE, the spectral representation of TPE in isentropic coordinates (STPE) is proposed. Diagnostic calculations using data from the Global Weather Experiment (GWE) are conducted for the 1978 to 1979 Northern Hemispheric winter to demonstrate the proposed forms. Time series of the various expressions in isentropic coordinates and the approximate form are compared. The diagnostic results show that the time series of the approximate form of APE does not adequately represent the time series of the complete form of APE. The results show that the usefulness of APE as a diagnostic property is in the decomposition of TPE into mean and derivation. The application of STPE to atmospheric energetics is demonstrated for 1978 to 1979 Northern Hemispheric winter with spherical harmonics used as basis-functions. Using STPE, energetics of the stratosphere can be separated from that of the troposphere. In the stratosphere zonal wave numbers one and two clearly show wave number one and two sudden stratospheric warmings (SSW). A troposphere-stratosphere interaction through pressure work is suggested. Dissert. Abstr.

**N89-17959*#** Michigan Univ., Ann Arbor. Physics Research Lab.
**NITRIC ACID OXIDE MIXING RATIO MEASUREMENTS USING A ROCKET LAUNCHED CHEMILUMINESCENT INSTRUMENT Final Technical Report, Sep. 1986 - Oct. 1987**
Jack J. Horvath 30 Jan. 1989 68 p
(Grant NAG5-230)
(NASA-CR-182957; NAS 1.26:182957) Avail: NTIS HC A04/MF A01 CSCL 04A

A total of 18 rocket launched parachute borne nitric oxide instruments were launched from 1977 to 1985. A very precise instrument for the measurement of the nitric oxide mixing ratio was fabricated. No changes were made in the main body of the instruments, i.e., things associated with the reaction volume. Except for the last 4 launches, however, it did not yield the required absolute values that was hoped for. Two major problems were encountered. First, the wrong choice of the background calibration gas, nitrogen, caused the first 10 data sets to be too low in the absolute mixing ratio by nearly the order of 2 to 5 ppbv. The error was realized, and air was substituted for the bias gas measurement. Second, in the desire to extend the measurement to higher altitudes, the problem of contaminating the inlet flow tube with ozone from the reagent gas was encountered. The ozone valve was opened too early in the flight and this caused the pressure in the reaction volume to exceed the pressure at the flow tube entrance, permitting the ozone to migrate backwards. This problem was restricted to an altitude above 45 km. Author

**N89-17960** Liverpool Univ. (England).
**MODELLING FLUCTUATIONS IN THE CONCENTRATION OF NEUTRALLY BUOYANT SUBSTANCES IN THE ATMOSPHERE Ph.D. Thesis**
David John Ride 1987 217 p
Avail: Univ. Microfilms Order No. BRDX82762

The probability density function (PDF) of the perceived concentration of a contaminant in the atmosphere is modeled using simple, physical representations of the dispersing contaminant. Sensors are characterized by the time taken to achieve a reading and by a threshold level of concentration below which the sensor does not respond and thus records a concentration of zero. A literature search of theoretical and experimental work concerning concentration fluctuations is conducted, and the merits - or otherwise - of of some common PDF's in common use are discussed. Dissert. Abstr.

**N89-17961#** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**INVESTIGATION OF THE DYNAMICS OF THE IONOSPHERE IN THE RANGE OF THE NORTHERN LIGHTS USING THE EISCAT IONOSPHERIC RADAR [UNTERSUCHUNG UEBER DIE DYNAMIK DER IONOSPHAERE IM BEREICH DES NORDLICHTS MIT HILFE DES EISCAT-IONOSPHAERENRADARS]**
Stephan Christoph Buchert Jul. 1988 108 p In GERMAN
(MPE-209; ISSN-0178-0719; ETN-89-93518) Copyright Avail: NTIS HC A06/MF A01

The interaction between polar ionosphere and magnetosphere, as well as the effects of high electric fields in the F region were investigated. Measurements with the EISCAT ionospheric radar and magnetometers allowed the determination of conductivity and electric fields in the range of the magnetic Ps6 pulsations. An electrostatic model for the Ps6 structures was developed. It was verified that the approximation of Maxwell-Boltzmann velocity distributions of the ions in the F region is acceptable for the interpretation of the measured Thomson scattering spectra. Ion temperature increases by up to a factor 10 can be explained by ohmic heating due to electric fields. ESA

**N89-17962#** Observatorio del Ebro, Roquetas (Spain).
**IONOSPHERE 1971, VOLUME 59 Annual Report, 1971 [BOLETIN DEL OBSERVATORIO DEL EBRO, VOLUME 59. 1971 IONOSFERA]**
J. O. Cardus and E. Galdon 1987 171 p In SPANISH
(ISSN-0211-5166; ETN-89-93753) Avail: NTIS HC A08/MF A01

Ionospheric data is presented per day and hour, at different for the E1, ES, F1, and F2 layers. The virtual height is approximated to 1 km for E1 and ES, and 5 km for the rest. The critical frequencies for E1 and ES are given with an error of 0.05 MHz, and those of F1 and F2 with less than 0.1 MHz. ESA

**N89-17963#** Observatorio del Ebro, Roquetas (Spain).
**IONOSPHERE 1972, VOLUME 60 Annual Report, 1972 [BOLETIN DEL OBSERVATORIO DEL EBRO, VOL. 60. 1972 IONOSFERA]**
J. O. Cardus and E. Galdon 1987 77 p In SPANISH
(ISSN-0211-5166; ETN-89-93754) Avail: NTIS HC A05/MF A01

Ionospheric data is presented per day and hour, at different frequencies for the E1, ES, F1, and F2 layers. The virtual height

is approximated to 1 km for E1 and ES, and 5 km for the rest. The critical frequencies for E1 and ES are given with an error of 0.05 MHz, and those of F1 and F2 with less than 0.1 MHz. ESA

**N89-17964#** International Centre for Theoretical Physics, Trieste (Italy).
**PHYSICAL AND THEORETICAL BASIS OF SOLAR-TERRESTRIAL RELATIONSHIPS. PART 1: EQUATORIAL LOCATIONS**
E. C. Njau Jul. 1988 14 p
(DE88-704705; IC-88/146) Avail: NTIS (US Sales Only) HC A03/MF A01

The theory of solar-terrestrial relationships developed earlier by the author is extended to incorporate expressions that represent the non-linear responses of the earth-atmosphere system to incoming solar radiation in a more detailed manner. Application of the extended theory to equatorial locations leads to new and interesting features that are consistent with past observations. It also predicts the existence of new oscillations in the equatorial atmosphere whose causative physical processes are given and explained. Non-equatorial locations are treated along similar lines in Part 2 of the series. DOE

**N89-17965#** International Centre for Theoretical Physics, Trieste (Italy).
**PHYSICAL AND THEORETICAL BASIS OF SOLAR-TERRESTRIAL RELATIONSHIPS. PART 2: NON-EQUATORIAL LOCATIONS**
E. C. Njau Jul. 1988 15 p
(DE88-704706; IC-88/147) Avail: NTIS (US Sales Only) HC A03/MF A01

The basic formulations presented in Part 1 of this series are modified in order to mathematically represent the expected solar-terrestrial influences in non-equatorial regions. Analysis and interpretation of these formulations lead to the establishment of several new periodicities as well as other features associated with the non-equatorial atmosphere. Besides, we show through suitable examples that the physical processes that cause and influence some previously observed climatic and upper atmospheric variations in temperate and polar regions are easily deduced from our formulations. DOE

**N89-17966#** Sandia National Labs., Albuquerque, NM. Geophysics Div.
**SEISMIC ARRAY PERFORMANCE ANALYSIS USING A HYBRID EXPERT SYSTEM**
Marianne C. Walck, Gregory J. Elbring, and Kathie L. Hiebert-Dodd Nov. 1988 38 p
(Contract DE-AC04-76DP-00789)
(DE89-004665; SAND-88-2410) Avail: NTIS HC A03/MF A01

Several factors contribute to the performance of a seismic array in locating events - configuration, frequency response, and distribution of sensor types are all important. Statistical analysis of the effect of these multiple variables on event location accuracy requires tedious repeated runs of analysis codes, using different input data sets and parameters. A hybrid expert system is an ideal tool to aid in processing and analyzing massive amounts of data and creating and manipulating a data base. This relatively new concept is a coupling of Artificial Intelligence (AI) programming techniques with analysis codes. Our expert system combines the individual strengths of an AI machine (Symbolics 3610) and conventional microcomputer (Micro VAX 2). Code written in Lisp on the Symbolics provides the user interface, maintains the data base and runs the desired FORTRAN codes, which reside on the Micro VAX 2. Functions are provided for entering data into the data base, analyzing data sets with respect to multiple variables, and inspecting the results in graphical form. The system is easily expandable to include new analysis methods. We demonstrate the capabilities of the hybrid expert system, ASSISTANT, using teleseismic data from the NORESS and ARCESS seismic arrays. DOE

**N89-17967#** National Center for Atmospheric Research, Boulder, CO.
**DESCRIPTION OF SOFTWARE FOR DETERMINATION OF NORMAL MODES OF THE NCAR (NATIONAL CENTER FOR ATMOSPHERIC RESEARCH) COMMUNITY CLIMATE MODEL**
Ronald M. Errico Dec. 1987 96 p
(Grant NSF ATM-82-17015)
(PB89-113989; NCAR/TN-277-STR) Avail: NTIS HC A05/MF A01 CSCL 04A

One contribution by Ronald M. Errico of the Large Scale Dynamics Section of NCAR's Atmospheric Analysis and Prediction Division to the development of NCAR's Community Climate Model (CCM) is described. The contribution is the development of software to determine the eigensolutions of a linearized version of the CCM. These eigensolutions may be used for diagnostic analysis, nonlinear normal-mode initialization for numerical weather prediction experiments, or other purposes. Although the software was designed for the CCM and its initialization, it should be easily modified for use with other models. GRA

**N89-17968#** Ohio State Univ., Columbus. Dept. of Geodetic Science and Surveying.
**GRAVITY FIELD APPROXIMATION USING THE PREDICTORS OF BJERHAMMAR AND HARDY**
George J. Priovolos Mar. 1988 144 p
(Contract F19628-86-K-0016; AF Proj. 7600)
(AD-A200622; OSU/DGSS-387; AFGL-TR-88-0114; SR-3) Avail: NTIS HC A07/MF A01 CSCL 08E

Gravity field approximation using the predictors of Bjerhammar and Hardy is investigated. In the Bjerhammar method, a finite number of observations is given and it is required to compute a disturbing potential which is harmonic down to a sphere fully internal to the Earth, regular at infinity and it satisfies all the observations. In the Hardy method, a particular family of density anomaly functions is selected which, together with its normal derivatives, vanishes at the boundary. The resulting disturbing potential is non-singular at points that induce potential. Both methods can use any linear functional of the disturbing potential as observation and/or quantity to be predicted. Both predictors were tested with the White Sands test data. Reference field and residual terrain model effects were removed from the observations and they were restored at the control stations after the predictions were performed. The best gravity anomaly predictions with both methods were performed with only delta g observations and the downward continuation onto the nadir points of the observations. The most important overall result of this work is that when reference field and residual terrain model effects are taken into account, there are at least five methods that can predict (xi,eta) from delta g to the sub-second level, even in mountainous areas. GRA

**N89-17969#** Stanford Univ., CA. Space Telecommunications and Radioscience Lab.
**ANALYSIS OF COORDINATED OBSERVATIONS IN THE REGION OF THE DAY SIDE POLAR CLEFT Final Report, 23 Oct. 1985 - 22 Oct. 1987**
D. L. Carpenter and C. R. Clauer Apr. 1988 125 p
(Contract F19628-85-K-0001; AF Proj. 2311)
(AD-A200627; AFGL-TR-88-0120) Avail: NTIS HC A06/MF A01 CSCL 04A

The objective of the research effort has been to develop electrodynamic models of the connectivity of the dayside high latitude ionosphere with the magnetosphere and solar wind. This is accomplished through the coordinated analysis of a variety of electrodynamic observations utilizing correlative satellite and ground data acquired in the vicinity of the polar cleft. Very strong evidence is found for a direct electrical connection between utilizing large scale field-aligned currents in the cleft region reproduces many of the time varying features in the observed high latitude ionospheric electrical fields and plasma convection. The small-scale current structures and expected ionospheric signatures are examined from localized coupling which would be expected from flux transfer events. Analysis of high latitude magnetic data from an array of magnetometers around Sondre Stromfjord Greenland

show impulsive events. These magnetic signatures are shown to result from pairs of small scale field-aligned current filaments moving tailward at about 4 km/sec over the array of stations. These events, however, are inconsistent with present models of FTE current systems. GRA

**N89-17970#** Analytic Sciences Corp., Reading, MA.
**A SYNOPSIS OF FIELD TEST RESULTS FROM THE GRAVITY GRADIOMETER SURVEY SYSTEM Technical Report, Jun. 1987 - May 1988**
S. J. Brzezowski and W. G. Heller 11 Aug. 1988 21 p
(Contract F19628-86-C-0077)
(AD-A200956; TASC-TR-5362-2; AFGL-TR-88-0176; SR-2) Avail: NTIS HC A03/MF A01 CSCL 08E

The Gravity Gradiometer Survey System (GGSS) has successfully collected data in both airborne and surface vehicle tests. The GGSS navigation system has demonstrated high accuracy and reliability for both the GPS-aiding and fifth-wheel aiding mechanizations. Track-to-track rms repeatability of the gravity disturbance estimates from the surface tests ranged from 2 to 3 mgal for tiepoints about 50 km apart. Comparison of airborne results with truth data yields rms discrepancies less than 5 mgal based on single-track analysis and tiepoint spacing of about 90 km, and less than 2 mgal for multi-track analysis and tiepoints about 80 km apart. Based on these test results, the GGSS offers a significant capability to perform full gravity vector surveys in a timely and economical manner. GRA

**N89-17971#** Defence Research Establishment Ottawa, (Ontario). Chemical Protection Section.
**DETERMINATION OF SEVERAL AEROSOL DISTRIBUTIONS**
J. R. Coleman Jun. 1988 38 p
(AD-A201046; DREO-TN-88-25) Avail: NTIS HC A03/MF A01 CSCL 07D

The use of two instruments, the electrostatic classifier (TSI 3071) and the condensation nucleus counter (CNC, TSI 3020), in the examination of aerosol size distributions is discussed. The classifier separates the aerosol into a series of narrow fractions on the basis of their electrical mobilities, and the CNC acts as a count instrument for the successive fractions. GRA

**N89-17972#** Computational Physics, Inc., Annandale, VA.
**UV BACKGROUND CALCULATIONS: RAYLEIGH SCATTERED AND DAYGLOW BACKGROUNDS FROM 1200 TO 3000 A Technical Report, Jan. - Apr. 1988**
D. J. Strickland, R. P. Barnes, and D. E. Anderson, Jr. (Naval Research Lab., Washington, DC.) 24 Aug. 1988 47 p
(Contract MIPR-FY7121-88-00004)
(AD-A201118; AFGL-TR-88-0200; SR-1) Avail: NTIS HC A03/MF A01 CSCL 04A

Dayglow and Rayleigh scattered sunlight for any satellite altitude and look direction are examined. Spectra may be generated from EUV to near IR wavelengths. Integrations may be formed over wavelength and look angle (for field-of-view averaging) for direct comparison with observations. Limb profiles are presented in 100 A bands from 1400 to 3000 A in units of megaRayleighs/A and microWatts/sq cm/sr. These profiles combine dayglow and Rayleigh scattered sunlight and show how the brightness varies over the tangent altitude range 300 to 0 km. Dayglow results are presented for high and low solar activity. There can be more than an order of magnitude variation in dayglow brightness at tangent altitudes above 200 km from low to high activity. We also present limb profiles of Rayleigh scattered sunlight showing the effect of changing the sun's azimuth. For a chosen solar zenith angle of 60, variations of more than 50 percent occur as the sun's azimuth changes from 0 to 90 deg. GRA

**N89-17973#** Massachusetts Inst. of Tech., Cambridge.
**INFLUENCE OF SCATTERING ON SEISMIC WAVES Final Report, 30 Jan. 1986 - 30 Jan. 1988**
M. N. Toksoz and Anton M. Dainty 8 Aug. 1988 100 p
(Contract F19628-86-K-0004)
(AD-A201120; AFGL-TR-88-0170) Avail: NTIS HC A05/MF A01 CSCL 08K

Work on this contract examined two subjects, the analysis of seismic data using the NORESS array in southern Norway and the attenuation properties of the crust. This document consists of two preprints. The first, Phase velocity estimation of diffusely scattered waves, deals with work at NORESS which was partly carried out under a previous contract, partly in conjunction with the Lawrence Livermore National Laboratory and partly under this contract. The second paper, A model for attenuation and scattering in the earth's crust, describes work on attenuation. GRA

**N89-17974*#** Texas Univ. at Dallas, Richardson. Center for Space Sciences.
**DETERMINATION OF THE IONOSPHERIC CONVECTION PATTERN FROM DMSP DATA Technical Report, Jun. 1987 - Jun. 1988**
Marc R. Hairston and Roderick A. Heelis Aug. 1988 9 p
(Contract NGR-44-004-120; F19628-87-K-0014)
(NASA-CR-184814; NAS 1.26:184814; AD-A201121; AFGL-TR-88-0298; SR-1) Avail: NTIS HC A02/MF A01 CSCL 04A

Thermal plasma instrumentation on the DMSP-F8, DMSP-F9, and future DMSP satellites may provide the first continuous long-term database of the ionospheric flow of plasma over both polar caps. Flow data from the satellites can be combined with a model magnetic field to calculate both the form and magnitude of the potential distribution across the polar cap. We are developing a model that will take the information about the potential distributions seen by both satellites and allow us to model the convection pattern over the entire polar cap region. A description of the data application is given along with a comparison of model and observed potential distributions. GRA

**N89-17975*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**CRUSTAL DYNAMICS PROJECT DATA ANALYSIS, 1988: VLBI GEODETIC RESULTS, 1979 - 1987**
C. Ma, J. W. Ryan, and D. Caprette (ST Systems Corp., Lanham, MD.) Feb. 1989 233 p
(NASA-TM-100723; Rept-89B00094; NAS 1.15:100723) Avail: NTIS HC A11/MF A01; also available as magnetic tape and as floppy disk from the Crustal Dynamic Project Data Information System, NASA, Goddard Space Flight Center, Greenbelt, MD CSCL 08G

The results obtained by the Goddard VLBI (very long base interferometry) Data Analysis Team from the analysis of 712 Mark 3 VLBI geodetic data sets acquired from fixed and mobile observing sites through the end of 1987 are reported. A large solution, GLB401, was used to obtain earth rotation parameters and site velocities. A second large solution, GLB405, was used to obtain baseline evolutions. Radio source positions were estimated globally while nutation offsets were estimated from each data set. Site positions are tabulated on a yearly basis from 1979 through 1988. The results include 55 sites and 270 baselines. Author

**N89-17750#** Boston Univ., MA. Dept. of Astronomy.
**MAGNETIC STORM EFFECTS ON F LAYER IRREGULARITIES NEAR THE AURORAL OVAL**
Jules Aarons and Alan S. Rodger (British Antarctic Survey, Cambridge, England ) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 10 p Sponsored in part by ONR, Washington, DC and National Environment Research Council, United Kingdom (For primary document see N89-17706 10-31) Copyright Avail: NTIS HC A23/MF A01

**N89-17751#** Lowell Univ., MA. Center for Atmospheric Research.
**SPECULAR SCATTER: A NEW MECHANISM FOR IONOSPHERIC BACKSCATTER**
Gary S. Sales *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 8 p (For primary document see N89-17706

10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17752#** Air Force Geophysics Lab., Hanscom AFB, MA.
**IONOSPHERIC SCINTILLATIONS AND IN-SITU MEASUREMENTS AT AN AURORAL LOCATION IN THE EUROPEAN SECTOR**
Santimay Basu, Sunanda Basu, Eileen MacKenzie, and Dan Weimer (Regis Coll., Weston, MA.) *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 12 p Sponsored in part by Defense Nuclear Agency, Washington, DC (For primary document see N89-17706 10-31)
(Contract F19628-86-K-0038)
Copyright Avail: NTIS HC A23/MF A01

**N89-17908#** Joint Publications Research Service, Arlington, VA.
**DEEP MAGNETOTELLURIC SOUNDING OF ALEUTIAN ISLAND ARC Abstract Only**
Yu. F. Moroz *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 1 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Zemli (Moscow, USSR), no. 1, Jan. 1988 p 96-99 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

**N89-17909#** Joint Publications Research Service, Arlington, VA.
**POSSIBILITIES OF INTERPRETING MAGNETOTELLURIC SOUNDINGS FROM PHASE CURVES Abstract Only**
V. G. Sekriyeru, G. V. Molochnov, and Yu. N. Kozulin *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 1-2 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Zemli (Moscow, USSR), no. 1, Jan. 1988 p 100-103 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

**N89-17916#** Joint Publications Research Service, Arlington, VA.
**ATTENUATION AND ABSORPTION OF RADIATION BY OPTICALLY SOFT CYLINDRICAL PARTICLES Abstract Only**
V. V. Kuznetsov and L. N. Pavlova *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 8 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery I Okeana (Moscow, USSR), v. 24, no. 2, Feb. 1988 p 205-211 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

**N89-17918#** Joint Publications Research Service, Arlington, VA.
**REGIONAL MODEL OF ATMOSPHERIC TRANSPORT OF POLYDISPERSE ADMIXTURE Abstract Only**
V. A. Borzilov, N. A. Veltishcheva, N. V. Klepnikova, M. A. Novitskiy, A. L. Burkov, and L. M. Metelkina *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 9 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 4, Apr. 1988 p 57-65 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

**N89-17923#** Joint Publications Research Service, Arlington, VA.
**FULL AND SELECTIVE INITIALIZATION IN SPECTRAL ATMOSPHERIC MODELS Abstract Only**
A. A. Ilin and A. N. Filatov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 11 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 3, Mar. 1988 p 5-16 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

**N89-17928#** Joint Publications Research Service, Arlington, VA.
**ACCURACY OF REFRACTOMETRIC METHOD IN HORIZONTALLY INHOMOGENEOUS ATMOSPHERE Abstract Only**
M. Ye. Gorbunov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 12-13 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery I Okeana (Moscow, USSR), v. 24, no. 5, May 1988 p 520-526 (For primary document see N89-17907 10-42)
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# 47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

**N89-17976** Wisconsin Univ., Madison.
**NONLINEAR OROGRAPHICALLY FORCED PLANETARY WAVES AND THEIR INTERACTIONS WITH SYNOPTIC-SCALE DISTURBANCES Ph.D. Thesis**
Robert Bradley Pierce 1988 218 p
Avail: Univ. Microfilms Order No. DA8810039

The planetary scale response to global orographic forcing is obtained within a nonlinear, steady state primitive equation model. The orographic response is shown to account for the primary features of the Northern Hemisphere January climatology. Quasi-geostrophic theory is used to determine the physical processes which determine the structure of the orographic response. Residual vorticity tendencies in the quasi-equilibrium orographic response and the climatological planetary waves are shown to be due to planetary scale divergence, which leads to retrograde motion. The stability of the orographic response is investigated utilizing a nonlinear, time dependent primitive equation model. Spectral kinetic energy budgets are used to determine the energy exchanges which are responsible for the amplification of the disturbances. Dissert. Abstr.

**N89-17977** Pennsylvania State Univ., University Park.
**CUMULUS PARAMETERIZATION STUDIES Ph.D. Thesis**
Charles Cohen 1988 191 p
Avail: Univ. Microfilms Order No. DA8817972

A cumulus parameterization is developed and used that will not merely produce a correct forecast, but will do so by simulating the same processes that directly control convection in the real atmosphere. This enables the parameterization to be used to produce numerical simulations that will reveal the behavior and influence of convection in the real atmosphere under a broad range of conditions. A diagnostic study examines the relative importance of the various physical processes that combine to produce the heating, drying, and precipitation in the one-dimensional cloud model that is used in the cumulus parameterization. Processes, such as lateral detrainment, that affect the net vertical mass flux of modeled clouds are shown to be most important to consider in developing the cumulus parameterization. The cumulus parameterization is used in a mesoscale numerical model to simulate tropical mesoscale convective systems. In a series of experiments with the mesoscale model, different types of large scale forcing are held constant and the response of the model atmosphere is examined. The influences of moisture, cooling, low level upward motion, synoptic scale easterly waves, and radiation on rainfall are examined.
Dissert. Abstr.

**N89-17978** Wyoming Univ., Laramie.
**THE MEASUREMENT OF TEMPERATURE FROM AN AIRCRAFT IN CLOUD Ph.D. Thesis**
R. Paul Lawson 1988 363 p
Avail: Univ. Microfilms Order No. DA8817691

The problem of wetting of thermometers used in research aircraft in cloud and precipitation has been previously recognized. Recently, a prototype radiometric thermometer became available for aircraft use which makes possible comprehensive evaluation of the immersion thermometers. This radiometer measures brightness temperature at 4.25 micron wavelength. At this wavelength, the fairly short path length and fast response of the sensing technique, makes comparisons with the immersion sensors meaningful. Based upon insights obtained in this research, a new immersion thermometer was designed to overcome the problems

with the conventional sensors. The design is based upon the principle of inertial separation of the water, and allows predictable response characteristics. Preliminary tests show that water does not reach the sensing element. Dissert. Abstr.

**N89-17979** Colorado State Univ., Fort Collins.
**A NUMERICAL INVESTIGATION OF TROPICAL SQUALL LINES Ph.D. Thesis**
Melville Edgar Nicholls 1987 205 p
Avail: Univ. Microfilms Order No. DA8808969

The structure and dynamics of tropical squall lines are investigated using 2-D and 3-D numerical models. Much of the structure found in squall lines is similar to the symmetrical response that might be expected of a nonsheared atmosphere to mid-level warming and low level cooling. Two-dimensional experiments underline the importance of shear in determining squall line characteristics. Two ideas concerning the effect of shear are found useful in explaining many of the outcomes of the numerical experiments. First, is that in two dimensions, shear in the absence of vorticity sources and sinks is detrimental to convection. Second, that there is a specific value of low level shear interacting with a cold pool which produces deep uplift and hence strong forcing of convection. Experiments are also carried out to determine the effect various thermodynamic structures have on squall line properties. Results suggest that moist mid-level air tends to be favorable for squall lines. Increasing the total buoyancy or altering the distribution of buoyance with height produces stronger systems with updrafts more tilted from the vertical. Dissert. Abstr.

**N89-17980#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**SOME METEOROLOGICAL MEANS OF THE PARAIBA VALLEY AND VICINITY [ALGUMAS MEDIAS METEOROLOGICAS DO VALE DO PARAIBA E PROXIMIDADES]**
Alberto W. Setzer and Alfredo daCostaPereira, Jr. Aug. 1988 50 p In PORTUGESE
(INPE-4661-RPE/573) Avail: NTIS HC A03/MF A01

Tables with monthly meteorological means are presented for the following cities of the Paraiba River Valley, SP, or its vicinity: Mogi das Cruzes, Sao Jose dos Campos, Taubate, Tremembe and Pindamonhangaba. The available data are: maximum, minimum and 12, 18 and 24 hr GMT temperatures; precipitation; atmospheric pressure at 12 hr; relative humidity, cloud cover, percentage of calm winds, wind speed and direction at 12, 18 and 24 hr. The data used were provided by INEMET and cover, at most, the 1961 to 1978 period. Also included are averages of INPE's station at Sao Jose dos Campos, SP, from 1979 to 1987, and two year means of types of plume dispersion close to Jacarei, SP. Author

**N89-17981*#** Wisconsin Univ., Madison. Space Science and Engineering Center.
**PROGRESS OF RESEARCH TO IDENTIFY ROTATING THUNDERSTORMS USING SATELLITE IMAGERY Final Report**
Charles E. Anderson 1 Dec. 1988 5 p
(Contract NAS8-36547)
(NASA-CR-183555; NAS 1.26:183555) Avail: NTIS HC A02/MF A01 CSCL 04B

The possibility of detecting potentially tornadic thunderstorm cells from geosynchronous satelite imagery is determined. During the life of the contract, we examined eight tornado outbreak cases which had a total of 124 individual thunderstorm cells, 37 of which were tornadic.These 37 cells produced a total of 119 tornadoes. The outflow characteristics of all the cells were measured. Through the use of a 2-D flow field model, we were able to simulate the downstream developmemt of an anvil cloud plume which was emitted by the storm updraft at or near the tropopause. We used two parameters to characterize the anvil plume oehavior: its speed of downstream propagation (U max) and the clockwise deviation of the centerline of the anvil plume from the storm relative ambient wind at the anvil plume outflow level (MDA). U max was the maximum U-component of the anvil wind parameter required to successfully maintain an envelope of translating particles at the tip of the expanding anvil cloud. MDA was the measured deviation angle acquired from McIDAS, between the storm relative ambient wind direction and the storm relative anvil plume outflow direction; tha latter being manipulated by controlling a tangential wind component to force the envelope of particles to maintain their position of surrounding the expanding outflow cloud. Author

**N89-17982#** Argonne National Lab., Idaho Falls, ID. Center for Environmental Research.
**MINISODAR MEASUREMENTS OF RAIN**
R. L. Coulter, T. J. Martin, and T. M. Weckwerth (Cornell Coll., Mount Vernon, IA.) 1988 31 p Presented at the 4th Symposium of the International Society of Acoustic Remote Sensing and 2d Australasian Conference on the Physics of Remote Sensing of Atmosphere and Ocean, Canberra, Australia, 16 Feb. 1988
(Contract W-31-109-eng-38)
(DE89-003885; CONF-8802114-1) Avail: NTIS HC A03/MF A01

Measurements of raindrop fall velocity spectra have been made with a minisodar. Amplitude calibration of the system enables the calculation of drop size parameters such as number density, water density, and surface area using methods similar to those with radar studies. The acoustic measurements are at 10 m intervals within 200 m of the surface and benefit from an almost complete separation of droplet velocity spectra from atmospheric vertical velocity spectra. Comparison of parameters with the literature shows good agreement. It is shown that the chief difficulty with the method is atmospheric attenuation; however, excess attenuation due to scattering from droplets is found to be unimportant. DOE

**N89-17983*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**RESEARCH HIGHLIGHTS OF THE GLOBAL MODELING AND SIMULATION BRANCH FOR 1986-1987**
Wayman Baker, ed., Joel Susskind, ed., James Pfaendtner, ed. (Sigma Data Services Corp., Reston, VA.), David Randall, ed., and Robert Atlas, ed. Dec. 1988 76 p
(NASA-TM-4085; Rept-88B0279; NAS 1.15:4085) Avail: NTIS HC A05/MF A01 CSCL 04B

This document provides a summary of the research conducted in the Global Modeling and Simulation Branch and highlights the most significant accomplishments in 1986 to 1987. The Branch has been the focal point for global weather and climate prediction research in the Laboratory for Atmospheres through the retrieval and use of satellite data, the development of global models and data assimilation techniques, the simulation of future observing systems, and the performance of atmospheric diagnostic studies. Author

**N89-17984#** International Centre for Theoretical Physics, Trieste (Italy).
**GENERALIZED THEORY OF SUN-CLIMATE/WEATHER LINK AND CLIMATIC CHANGE**
E. C. Njau Jul. 1988 15 p
(DE88-704712; IC-88/155) Avail: NTIS (US Sales Only) HC A03/MF A01

We generalize the theory of Sun-climate/weather links and climatic change developed earlier by the author. On the basis of this theory, we show mathematically that key climatic/weather parameters are continuously subjected to determinable amplitude modulations and other variations which may be useful in climatic prediction work. A number of new and known terrestrial oscillations in climate and atmospheric behavior in general, including the known quasi-biennial oscillations and many others, are deduced from the theory and accounted for in terms of their causative physical processes. Finally we briefly discuss the possibility of applying the theory to the planets Mars and Venus as well as Saturn's largest satellite, Titan. DOE

**N89-17985#** Dugway Proving Ground, UT.
**FIELD TEST OF A CROSSWIND SCINTILLOMETER Test Report, Nov. 1987 - Jul. 1988**

Christopher A. Biltoft 21 Jul. 1988 61 p
(AD-A200697; DPG-FR-88-317) Avail: NTIS HC A04/MF A01 CSCL 04B

Field tests of a prototype scintillometer that uses a spatially-averaged filter design for crosswind measurement were conducted at the Aberdeen Proving Ground Main Front Gun Range. The scintillometer measures wind components transverse to an optical path established between a transmitter and a receiver. The spatially-averaged filter design peaks wind measurement weighting functions at five segments along the optical path, producing simultaneous crosswind readings from these path segments. Scintillometer performance, evaluated using sonic anemo-meters, GMQ-11 aerovanes, and parallel scintillometer paths, is generally comparable to that of a high quality wind instrument. A performance problem was identified during cross-path wind reversals in light and variable winds, where ambiguities in the sign of the crossing wind component occasionally caused spurious wind readings. The scintillometer design is sufficiently robust for field use, and the transmitters and receivers are easy to set up, align, and operate. The crosswind scintillometer performed well in the field environment during exposure to adverse weather conditions, and appears to have significant test applications. GRA

**N89-17986#** Hydrologic Engineering Center, Davis, CA.
**THE ESTIMATION OF RAINFALL FOR FLOOD FORECASTING USING RADAR AND RAIN GAGE DATA**
William J. Charley Sep. 1988 12 p
(AD-A200802; HEC-TP-122) Avail: NTIS HC A03/MF A01 CSCL 04B

An inadequate knowledge of the magnitude and spatial distribution of precipitation is often a major limitation in developing accurate river-flow forecasts for use in reservoir operations. Digitized weather radar data can provide useful information regarding the spatial distribution of rainfall, although radar-based estimates of rainfall may be in error due to several factors. The use of radar-rainfall data in combination with rain gage measurements may improve rainfall estimates over those based on either form of measurement alone. This improvement is accomplished by adjusting, or calibrating, radar-rainfall data with data from rain gages situated within the radar boundary. A set of rainfall analysis software that incorporates this methodology has been developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center to aid hydrologists in making real-time water control decisions. The rainfall-analysis software retrieves real-time radar-rainfall data from a National Weather Service RADAP II (Radar Data Processor), and rain gage measurements from data collection platforms via the Geostationary Operational Environmental Satellite (GOES). The radar data from the RADAP II is calibrated with the rain gage data using a simple Kriging technique. Subbasin-average rainfall is then computed from the calibrated data and stored in a data base file subsequent use by a river-flow forecast model. GRA

**N89-17987#** California Inst. of Tech., Pasadena. Big Bear Solar Observatory.
**A SIMPLE SOLAR MICROWAVE BURST OBSERVED WITH HIGH SPECTRAL RESOLUTION**
Dale E. Gary and G. J. Hurford Aug. 1988 22 p
(Contract F19628-86-K-0017)
(AD-A201003; AFGL-TR-88-0248; SR-1) Avail: NTIS HC A03/MF A01 CSCL 03B

Many solar microwave bursts exhibit multicomponent spatial and spectral structure, which complicates efforts to determine source parameters from their radio emission. A small (SN/C1.0) flare that occurred on 1986 February 3 is dominated by a single, homogeneous source. High spectral resolution observations of this event with the Owens Valley frequency-agile interferometer therefore provide the clearest opportunity to date to apply theoretical spectral models to a microwave burst. Based on the microwave spectra, we find that the burst was dominated by a compact, thermal source. The sequence of such spectra, obtained every 10 s, showed that the source expanded with time during the burst, starting with a (one-dimensional) size of 4 arcsec, enlarging to about 12 arcsec in less than 2 minutes. During the same period, the electron temperature decreased from a high 71 million K to less than 10 million K. Comparison with GOES soft X-ray data suggests that the density increased by at least an order of magnitude during the burst. The magnetic field strength was found to be about 770 G. To apply these techniques to typical, more inhomogeneous flares, future observations are needed that achieve better imaging capability while retaining high spectral resolution. GRA

**N89-17988** Deutscher Wetterdienst, Offenbach am Main (Germany, F.R.).
**ANNALS FROM THE GERMAN METEOROLOGICAL SOCIETY. NO. 24: MEMORIAL COLLOQUIUM FOR K. H. HINKELMANN**
1988 74 p Partly in ENGLISH and GERMAN Colloquim held in Mainz, Fed. Republic of Germany, 14 May 1987
(ISBN-3-88-148238-5; ISSN-0072-4122; ETN-89-93654)
Copyright Avail: Deutscher Wetterdienst, Frankfurter Strasse 135, D-6050 Offenbach am Main, Fed. Republic of Germany

The life and the scientific activities of professor Karl Heinz Hinkelmann are presented. The problem of the fluctuation-dissipation relation, and its application to turbulent atmospheric flow are treated. Filtering and initialization as methods of suppressing gravity waves in atmospheric motion are also studied. The third generation of numerical weather forecasting of the German Meteorological Service is described. For individual titles, see N89-17989 through N89-17992.

**N89-17989** Deutscher Wetterdienst, Offenbach am Main (Germany, F.R.).
**LIFE AND SCIENTIFIC WORK OF KARL-HEINZ HINKELMANN [KARL-HEINZ HINKELMANN - LEBEN UND WISSENSCHAFTLICHES WIRKEN]**
Fritz Wippermann *In its* Annals from the German Meteorological Society. No. 24: Memorial Colloquium for K. H. Hinkelmann 1988 p 9-16 In GERMAN (For primary document see N89-17988 10-47)
Copyright Avail: Deutscher Wetterdienst, Frankfurter Strasse 135, D-6050 Offenbach am Main, Federal Republic of Germany

The life and career of Professor Karl-Heinz Hinkelmann are sketched. His scientific activities were situated in the fields of numerical weather forecasting. Topics with which he was concerned were unfiltered models, baroclinic models, quantitative methods for the prediction of atmospheric state changes, barotropic forecast calculations, and parameterization of turbulent flow. ESA

**N89-17990** Deutscher Wetterdienst, Offenbach am Main (Germany, F.R.).
**THE PROBLEM OF THE FLUCTUATION-DISSIPATION RELATION [ZUM PROBLEM DER FLUKTUATIONS-DISSIPATIONS-RELATION]**
Heinz Fortak *In its* Annals from the German Meteorological Society. No. 24: Memorial Colloquium for K. H. Hinkelmann 1988 p 17-36 In GERMAN (For primary document see N89-17988 10-47)
Copyright Avail: Deutscher Wetterdienst, Frankfurter Strasse 135, D-6050 Offenbach am Main, Federal Republic of Germany

The problem of the fluctuation-dissipation relation and its application to turbulent atmospheric flow are treated. The basic equations of thermohydrodynamics for the supermolecular (laboratory) scale are presented; they form a reliable model description of the local conditions in a continuum and for conditions inside the global atmosphere. The representation of the state of the atmosphere in the state space of the variables is discussed. The nonobservable fluctuations are coupled with the dissipations (not only the friction-determined, but also each correlation which has to be parameterized). The equation systems for the synoptic and turbulent subspaces are introduced. The stationary linear stochastic subsystem is presented. The formal solution of the complete system for the stochastic state vector is given. ESA

**N89-17991** Deutscher Wetterdienst, Offenbach am Main (Germany, F.R.).
**METHODS OF SUPPRESSING GRAVITY WAVE SOLUTIONS: THE RELATION BETWEEN INITIALIZATION AND FILTERING**
Philip Thompson *In its* Annals from the German Meteorological Society. No. 24: Memorial Colloquium for K. H. Hinkelmann 1988 p 37-59 (For primary document see N89-17988 10-47)
Copyright Avail: Deutscher Wetterdienst, Frankfurter Strasse 135, D-6050 Offenbach am Main, Federal Republic of Germany

Filtering and initialization as methods of suppressing gravity waves in atmospheric motions, for numerical weather forecasting, are discussed. The exclusion of gravity waves as solutions of a linear and a nonlinear system is outlined. The suppression of gravity waves by initialization in a linear and a nonlinear system is explained. The method of nonlinear normal mode initialization and the methods of combined initialization and filtering are presented. ESA

**N89-17992** Deutscher Wetterdienst, Offenbach am Main (Germany, F.R.).
**THE THIRD GENERATION OF THE NUMERICAL WEATHER FORECASTING SYSTEM OF THE GERMAN METEOROLOGICAL SERVICE: METEOROLOGICAL CONCEPT AND RESEARCH POTENTIAL [DIE DRITTE GENERATION DES NUMERISCHEN WETTERVORHERSAGESYSTEMS BEIM DWD: METEOROLOGISCHES KONZEPT UND FORSCHUNGSPOTENTIAL]**
Eberhard Mueller *In its* Annals from the German Meteorological Society. No. 24: Memorial Colloquium for K. H. Hinkelmann 1988 p 60-72 In GERMAN (For primary document see N89-17988 10-47)
Copyright Avail: Deutscher Wetterdienst, Frankfurter Strasse 135, D-6050 Offenbach am Main, Federal Republic of Germany

The perspectives of numerical weather forecasting (NWF) of the German Meteorological Service are outlined. The NWF-system concept contains a chain of models with decreasing spatial extension and increasing numerical resolution. This allows handling of available data and physical processes with different resolutions. The different components of the chain (global model, Europe model, Germany model, landscape model) are described. Initial and boundary conditions, physical content, verification, and presentation are discussed. Applications are presented. ESA

**N89-17913#** Joint Publications Research Service, Arlington, VA.
**METHODS FOR COMPUTING WIND AND WAVES IN TROPICAL HURRICANES Abstract Only**
K. V. Pokazeyev and M. Yu. Tyurikov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 5-6 Transl. into ENGLISH of Gidrometeorologiya. Seriya 37.25, Okeanologiya No. 1, Metody Rascheta Vetra I Voln V Tropicheskikh Uraganakh (Obninsk, USSR), 1988 p 1-48 (For primary document see N89-17907 10-42)
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**N89-17917#** Joint Publications Research Service, Arlington, VA.
**USE OF STATISTICAL METHODS FOR PREDICTING HAIL PROCESSES AND THEIR CHARACTERISTICS Abstract Only**
L. M. Fedchenko and A. Kh. Kagermazov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 1 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 4, Apr. 1988 p 41-50 (For primary document see N89-17907 10-42)
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**N89-17919#** Joint Publications Research Service, Arlington, VA.
**JOINT MONITORING OF GEOPOTENTIAL AND TEMPERATURE USING LEVEL-2 FGGE DATA Abstract Only**
A. D. Naumov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 9-10 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 4, Apr. 1988 p 116-123 (For primary document see N89-17907 10-42)
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**N89-17924#** Joint Publications Research Service, Arlington, VA.
**INFLUENCE OF RADIATION REGIME CHANGES IN AIR TEMPERATURE AT LAND AND OCEAN SURFACE Abstract Only**
M. L. Asaturov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 11 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 3, Mar. 1988 p 17-28 (For primary document see N89-17907 10-42)
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**N89-17925#** Joint Publications Research Service, Arlington, VA.
**RESEARCH ON ICE-FORMING EFFICIENCY OF AgI AND PbI2 PYROTECHNIC NUCLEANTS IN STRATIFORM CLOUDS Abstract Only**
M. Ya. Aksenov, T. V. Bazzayev, B. N. Leskov, and N. O. Plaude *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 11-12 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 3, Mar. 1988 p 41-47 (For primary document see N89-17907 10-42)
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**N89-17938#** Institut fuer Angewandte Geodaesie, Frankfurt am Main (Germany, F.R.).
**VISUAL PERCEPTION OF TELEVISION WEATHER FORECAST MAPS [VISUELLE WAHRNEHMUNG VON FERNSEH-WETTERKARTEN]**
Rene Sieber *In its* Reports on Cartography and Geodesy, Series 1, Number 100 1988 p 31-48 In GERMAN; ENGLISH summary (For primary document see N89-17935 10-43)
Avail: NTIS HC A05/MF A01

# 48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

**N89-17993#** Naval Postgraduate School, Monterey, CA.
**NUMERICAL OCEAN PREDICTION IN THE CALIFORNIA COASTAL REGION USING A HIGH-RESOLUTION PRIMITIVE EQUATION MODEL M.S. Thesis**
Clifford D. Johnson Jun. 1988 52 p
(AD-A200623; NPS68-88-007) Avail: NTIS HC A04/MF A01 CSCL 08C

A high resolution, multi-level, primitive equation (PE) model of the California coastal region is initialized with a temperature field analyzed from real data collected during the OPTOMA11 cruises of June and July, 1984, for the purpose of forecasting the movement of thermal features in the region. The results are compared to the observations and to the forecast experiments of Rienecker et al. (1987), since they initialized their quasi-geostrophic (QG) model with the same OPTOMA11 temperature data. Key prediction features include an anticyclone and cyclone pair, and an offshore Jet that was formed between the pair with velocities on the order of 60 cm/sec in the upper ocean region (less than 225m). The temperature front associated with this jet is traced at the 85m level, in a time series from day 0 to day 14, as is the perturbation pressure field. Translational velocities of this frontal feature are on the order of 5 to 10 cm/sec in a southward direction, which is consistent with those observed. Some quantitative differences between the PE model prediction and the QG model are found. Based on these cast by a multi-level, high resolution PE model, given synoptic data for initialization. However, many more studies are needed to understand the dynamics and robustness of the present model predictions. GRA

**N89-17994#** Naval Postgraduate School, Monterey, CA.
**WIND FORCING OF EDDIES AND JETS IN THE CALIFORNIA CURRENT SYSTEM M.S. Thesis**
Terrance A. Tielking Jun. 1988 118 p
(AD-A200946; NPS-68-88-006) Avail: NTIS HC A06/MF A01 CSCL 08C

A high-resolution, multi-level, primitive equation ocean model is used to examine the response to wind forcing of an idealized flatbottomed oceanic regime along an eastern ocean boundary. A band of steady winds, either with or without a curl, is used as forcing on both an f-plane and a beta-plane. In addition, a stability analysis is made to determine if the necessary and sufficient conditions for instability processes to occur are satisfied. It is seen that when the wind driven coastal jet and undercurrent are unstable (which occurs in the cases of wind with no curl), eddies and jets are generated. In the case of wind with curl, since the Davidson Current develops rather than the coastal jet and undercurrent, no eddies develop. A comparison of model results with available observations shows that both the time-averaged and instantaneous model simulations of the coastal jet, undercurrent and eddies are consistent with available observational data. Study results support the hypothesis that wind forcing can be an important eddy generation mechanism for the California Current System. GRA

**N89-17995#** Science Applications International Corp., College Station, TX. Applied Environmental Sciences Div.
**PHYSICAL PROCESSES RELATED TO SEA-ICE DIVERGENCE Final Report**
James K. Lewis and Maria R. Giuffrida Oct. 1988 11 p
(Contract N00014-87-C-0173)
(AD-A201122; SAIC-88/1801) Avail: NTIS HC A03/MF A01 CSCL 08L

This report documents the results of a study of a number of sea ice processes in the Arctic Basin. Seasonal sea ice kinematics were closely scrutinized, and their space and time scales calculated. Factors concerning sea ice thermodynamics were also considered. Direct comparisons were made between observed ice velocities and corresponding ice velocities from the Polar Ice Prediction System (PIPS). One of the primary objectives of this work was to provide a wide range of information with which one could validate the mechanics and predictions of the PIPS. Factors that were studied include the grid size and time step of the PIPS, the scale of important forcing variables, the formulation of heat fluxes within the model ice field, and steps to be considered in the attempt to produce the most realistic predictions possible. GRA

**N89-17911#** Joint Publications Research Service, Arlington, VA.
**STATIONARY POWER SPECTRA OF TWO-DIMENSIONAL TURBULENCE IN SINGLE-LAYER OCEAN WITH FREE SURFACE ON BETA-PLANE Abstract Only**
R. S. Iroshnikov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 4 Transl. into ENGLISH from Doklady Akademii Nauk SSSR (Moscow, USSR), v. 299, no. 2, Mar. 1988 p 312-317 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

**N89-17912#** Joint Publications Research Service, Arlington, VA.
**EXPERIMENTAL RESEARCH ON LOW-FREQUENCY ACOUSTIC FIELDS IN OCEAN AND EVALUATION OF POSSIBILITIES OF PREDICTING THEIR CHARACTERISTICS Abstract Only**
D. I. Abrosimov, V. S. Averbakh, L. S. Dolin, P. A. Kapustin, A. G. Luchinin, V. N. Nekrasov, A. G. Nechayev, L. A. Ostrovskiy, Ye. A. Plakhin, and A. M. Podrazhanskiy et al *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 4-5 Transl. into ENGLISH from Doklady Akademii Nauk SSSR (Moscow, USSR), v. 299, no. 2, Mar. 1988 p 477-481 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

**N89-17914#** Joint Publications Research Service, Arlington, VA.
**STATISTICAL CORRELATIONS OF HYDROMETEOROLOGICAL PARAMETERS OF NORWEGIAN SEA AND ADJACENT REGIONS OF NORTH ATLANTIC Abstract Only**
P. Ye. Shirokov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 6 Transl. into ENGLISH from Izvestiya Vsesoyuznogo Geograficheskogo Obshchestva (Leningrad, USSR), v. 120, no. 3, May-Jun. 1988 p 265-269 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

**N89-17926#** Joint Publications Research Service, Arlington, VA.
**WATER TEMPERATURE CHANGE BELOW ACTIVE LAYER IN NORTH ATLANTIC OCEAN Abstract Only**
D. I. Antonov and P. Ya. Groysman *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 12 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 3, Mar. 1988 p 57-63 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

**N89-17929#** Joint Publications Research Service, Arlington, VA.
**COMPUTATION OF NONLINEAR ENERGY TRANSFER IN SPECTRUM OF WIND WAVES Abstract Only**
V. A. Kalmykov *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 13 Transl. into ENGLISH from Meteorologiya i Gidrologiya (Moscow, USSR), no. 5, May 19888 p 95-102 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

# 51 LIFE SCIENCES (GENERAL)

**N89-17996*#** Massachusetts Inst. of Tech., Cambridge. Man-Vehicle Lab.
**[MIT-KSC SPACE LIFE SCIENCES TELESCIENCE TESTBED] Final Technical Report**
Feb. 1989 21 p
(Grant NAGw-1092)
(NASA-CR-184769; NAS 1.26:184769; OSP-99187) Avail: NTIS HC A03/MF A01 CSCL 06C

A Telescience Life Sciences Testbed is being developed. The first phase of this effort consisted of defining the experiments to be performed, investigating the various possible means of communication between KSC and MIT, and developing software and hardware support. The experiments chosen were two vestibular sled experiments: a study of ocular torsion produced by Y axis linear acceleration, based on the Spacelab D-1 072 Vestibular Experiment performed pre- and post-flight at KSC; and an optokinetic nystagmus (OKN)/linear acceleration interaction experiment. These two experiments were meant to simulate actual experiments that might be performed on the Space Station and to be representative of space life sciences experiments in general in their use of crew time and communications resources. Author

**N89-17997*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**PROCEEDINGS OF A CONFERENCE ON CARDIOVASCULAR BIOINSTRUMENTATION**
Rodney W. Ballard, Charles A. Fuller, Richard Mains, and Herbert J. Finger Dec. 1988 71 p Conference held at Moffett Field, CA, 21-22 Jul. 1987
(NASA-CP-10022; A-88120; NAS 1.55:10022) Avail: NTIS HC A04/MF A01 CSCL 06C

The Ames Research Center (ARC) has a long history in the development of cardiovascular (CV) instrumentation for human and animal research. The ARC Cardiovascular Research Lab under the Space Physiology Branch, Space Research Directorate, supports both ground-based and space-based animal and human

research goals. The Cardiovascular Research Laboratory was established at ARC in the mid 1960's to conduct ground-based animal research and support development of advanced cardiovascular instrumentation applicable to spaceflight. The ARC Biomedical Research Program also conducts human studies with a CV instrumentation focus. Author

**N89-17998#** Medical Coll. of Virginia, Richmond. Dept. of Physiology and Biophysics.
**RADIOFREQUENCY/MICROWAVE CELL ABSORPTION AND ACTION SPECTROSCOPY Annual Report, 1 Sep. 1987 - 1 Oct. 1988**
Stephen F. Cleary and Li-Ming Liu 25 Nov. 1988 22 p
(Contract N00014-84-K-0539; RR04108)
(AD-A201017) Avail: NTIS HC A03/MF A01 CSCL 06D

Dielectric properties (viz real and imaginary components of the complex dielectric constant, and the absorption coefficient) were determined for mammalian cells and viruses over the frequency range 50- to 26,400 MHz. Dielectric properties were determined by using an open probe technique which measured the complex reflection coefficient using a Hewlett Packard 8510 network analyzer and associated data processing system. Independent variables investigated included: temperature, cell cycle, metabolic inhibitors, anesthetic agents, ionophores, and fixatives. Under certain conditions, these variables affected the dielectric properties of cells or viruses. No firm evidence of resonant-like absorption of radiofrequency radiation in cell or viral macromolecules, such as DNA, has been obtained. GRA

**N89-17999#** Army Research Inst. of Environmental Medicine, Natick, MA.
**HYPERTHERMIA IMPAIRS RETENTION OF AN OVERTRAINED SPATIAL TASK IN THE MORRIS WATER MAZE**
T. M. Rauch, D. I. Welch, and L. Gallego 4 Nov. 1988 22 p
(AD-A201064) Avail: NTIS HC A03/MF A01 CSCL 06J

Fifteen rats were trained to learn the location of a spatially fixed platform hidden in a Morris water maze (40 + or - 2 C). Then retention of the spatial task was assessed immediately after raising core body temperature (T sub c) to 42, 40 or 37 C (the normothermic control). The hyperthermic treatment order was counterbalanced according to a Latin-square design. Hyperthermia at 42 C T sub c significantly impaired the retention of spatial performance. Hyperthermic animals were cooled to normothermia (T sub c = 37 C) and spatial performance tested again. Recooling resulted in a complete recovery of spatial performance. These results demonstrate that hyperthermia-induced amnesia can be obtained on an overtrained spatial mapping strategy and recooling initiates recovery of spatial performance. GRA

**N89-18396*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**ANIMALS IN SPACE**
Angela White *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 135-141 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 06C

# 52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

**N89-18000#** National Library of Medicine, Bethesda, MD.
**PERMUTED MEDICAL SUBJECT HEADINGS, 1989**
Jul. 1988 446 p
(PB88-100036; NLM/MED-89/03) Avail: NTIS HC A19/MF A01 CSCL 06P

Permuted Medical Subject Headings, 1989, is a computer generated display of all terms, i.e., descriptors and cross references, in alphabetic list of the National Library of Medicine's Medical Subject Headings (MeSH) for 1988, as well as all citation type, check tag, and geographic descriptors in the Annotated Alphabetic MeSH, 1989. The Permuted MeSH takes each significant word that appears in each MeSH term and then lists all the MeSH terms in which that word appears. Author

**N89-18001#** Institut fuer Rundfunktechnik, Munich (Germany, F.R.).
**THE IMPAIRMENT OF THE REPRESENTATION OF MOTION BY ALIAS EFFECTS AT DIFFERENT FIELD FREQUENCIES AND OBJECT SPEEDS [DIE BEEINTRAECHTIGUNG DER BEWEGUNGSDARSTELLUNG DURCH ALIAS-EFFEKTE BEI VERSCHIEDENEN BILDWECHSELFREQUENZEN UND OBJEKTGESCHWINDIGKEITEN]**
Alexander Schertz and H. Wilkens 12 Jan. 1987 26 p In GERMAN
(TB-81/86; ETN-89-93511) Avail: NTIS HC A03/MF A01

Tests were performed in order to investigate the dependence of alias effects on the field rate in the representation of motion. The test conditions were optimized by measures to fix the eyes. The field frequency as well as the speed were varied. The test results confirm the results of a previous investigation which showed that a higher field rate substantially improves the resolution of the motion. A frequency increase from 50 to 60Hz already brings a detectable improvement of the quality of the motion representation. In the frequency range from 50 to 100Hz the impairment decreases linearly with increasing frequency for a medium speed. For lower speeds, the improvement saturates with frequency, for higher speeds the worst quality occurs at 50 and 60 Hz. ESA

**N89-18002#** International Centre for Theoretical Physics, Trieste (Italy).
**CONTRIBUTION OF ULTRASOUND FORWARD SCATTERING TO TISSUE STRUCTURE STUDY**
M. K. Edee Dec. 1987 23 p
(DE88-704690; IC-87/355) Avail: NTIS (US Sales Only) HC A03/MF A01

In this paper, we show how to get useful information of tissue structure by merely interpreting some experimental graphs such as energy spectral density and autocorrelation function of an ultrasonic beam travelling through tissues. To support these interpretations, we needed just some well-known theorems rather than heavy and complicated mathematical equations, so we measured the dimensions of scatterers within specimens by using the graphical representation of autocorrelation function. We related these measurements to the scattered peaks which appear in energy density spectrum. The values we found were equal to those obtained from biologists within approx. 15 percent. DOE

**N89-18003#** Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
**PHYSIOLOGICAL RESEARCH ON THE CENTRIFUGE IN FLIGHT MEDICAL EXAMINATIONS AND SELECTION SYSTEM**
P. M. Suvorov 9 Nov. 1988 43 p Transl. into ENGLISH of Fiziologicheskiye Issledovaniya na Tsentrifuge v Praktike Vrachebno-Letnoy Ekspertizy i Sisteme Otbora (Moscow, USSR), 1969 p 1-30
(AD-A200906; FTD-ID(RS)T-0892-88) Avail: NTIS HC A03/MF A01 CSCL 06J

The main objective of this ten year study was to develop, validate and introduce into flight medical examination practice and the system of selecting a special contingent, a new functional method of examination with the effects of prolonged accelerations. GRA

**N89-18004#** Army Research Inst. of Environmental Medicine, Natick, MA.
**DESYNCHRONIZATION OF BIOLOGICAL RHYTHMS IN ATHLETES: JET LAG Report, for Period Ending Oct. 1988**
Lawrence E. Armstrong 17 Oct. 1988 12 p
(AD-A201060) Avail: NTIS HC A03/MF A01 CSCL 06D

This article reviews the human biological rhythms which alter performance, and the ways that human biological rhythms are desynchronized--focusing on transmeridian air travel (jet lag).

Recommendations for resynchronizing biological/circadian rhythms are presented, based on the work of several authors. Because of the journal involved, athletic populations are highlighted. GRA

**N89-18005#** Army Research Inst. of Environmental Medicine, Natick, MA. Exercise Physiology Div.
**FACTORS IN MAXIMAL POWER PRODUCTION AND IN EXERCISE ENDURANCE RELATIVE TO MAXIMAL POWER Report, for Aug. 1986 - Oct. 1988**
John F. Patton, W. J. Kraemer, H. G. Knuttgen, and E. A. Harman 13 Oct. 1988 28 p
(AD-A201062) Avail: NTIS HC A03/MF A01 CSCL 06D

The relationship of muscle fiber type and mass to maximal power production and the maintenance of power (endurance time to exhaustion) at 36, 55, and 73 percent of maximal power was investigated in 18 untrained but physically active male subjects. Power output was determined at constant velocity (60 RPM) on a high intensity cycle ergometer instrumented with force transducers and interfaced with a computer. Fat free mass was determined by hydro-static weighing, fat free thigh volume by water displacement and skinfold measurement, and percentage and area of type 2 fibers from biopsies of the vastus lateralis. Maximal power averaged 771 + or - 149 W with a range of 527 to 1125 W. No significant correlations were found among percentage of type 2 fibers, relative area of type 2 fibers, or fat free thigh volume and maximal power or endurance times to exhaustion at any percentage of maximal power. Weak but significant relationships were found for fat free mass with both maximal power ($r=0.57$) and endurance time at 73 percent of maximal power ($r=0.47$). These results show maximal power to be more dependent on factors related to body size than muscle fibers characteristics. GRA

**N89-18006#** Army Research Inst. of Environmental Medicine, Natick, MA.
**THE MASS-TO-SURFACE AREA INDEX OF HEAT TOLERANCE IN A LARGE COHORT Report, for Aug. - Oct. 1988**
Lawrence E. Armstrong, Jane P. DeLuca, Elaine L. Christensen, and Roger W. Hubbard 19 Oct. 1988 30 p
(AD-A201063) Avail: NTIS HC A03/MF A01 CSCL 06J

No large Mass-to-Surface Area (M/SA) data base exists which can be used as a reference standard to interpret previous or future M/SA studies. This report presents the M/SA data of a large military cohort (1170 males aged 17 to 54 yr, 305 females aged 17 to 40 yr). The effects of gender, race and age on the distribution of M/SA, as well as the relationship between M/SA and other physical characteristics, were described. It was observed that the increases of M/SA with increasing age (over the 17 to 25 yr category) were not significant. All descriptive characteristics (including M/SA) were different between males and females. M/Sa was not statistically different between racial groups, in both males and females. For the first time, two step-wise multiple linear regression equations were presented which allow accurate prediction of M/SA in males and females, using only height and body mass as the dependent variables; these equations were as follows. Recommendations for future studies and criticisms of subject selection in previous studies, which did not have the benefit of this data base during the process of subject selection, are presented. GRA

**N89-18381*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**MOTION SICKNESS: CAN IT BE CONTROLLED**
David Carnes *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 21-23 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 06E

# 53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**N89-18007*#** McDonnell-Douglas Astronautics Co., Huntington Beach, CA.
**SPACE STATION FUNCTIONAL RELATIONSHIPS ANALYSIS Final Technical Report**
Thomas S. Tullis and Barbra R. Bied Aug. 1988 112 p
(Contract NAS2-11723)
(NASA-CR-177497; NAS 1.26:177497; MDC-H3068) Avail: NTIS HC A06/MF A01 CSCL 05I

A systems engineering process is developed to assist Space Station designers to understand the underlying operational system of the facility so that it can be physically arranged and configured to support crew productivity. The study analyzes the operational system proposed for the Space Station in terms of mission functions, crew activities, and functional relationships in order to develop a quantitative model for evaluation of interior layouts, configuration, and traffic analysis for any Station configuration. Development of the model involved identification of crew functions, required support equipment, criteria of assessing functional relationships, and tools for analyzing functional relationship matrices, as well as analyses of crew transition frequency, sequential dependencies, support equipment requirements, potential for noise interference, need for privacy, and overall compatability of functions. The model can be used for analyzing crew functions for the Initial Operating Capability of the Station and for detecting relationships among these functions. Note: This process (FRA) was used during Phase B design studies to test optional layouts of the Space Station habitat module. The process is now being automated as a computer model for use in layout testing of the Space Station laboratory modules during Phase C.
Author

**N89-18008*#** Search Technology, Inc., Norcross, GA.
**HUMAN OPERATOR RESPONSE TO ERROR-LIKELY SITUATIONS IN COMPLEX ENGINEERING SYSTEMS**
Nancy M. Morris and William B. Rouse Aug. 1988 47 p
(Contract NAS2-12048)
(NASA-CR-177484; T-3227; NAS 1.26:177484) Avail: NTIS HC A03/MF A01 CSCL 05I

The causes of human error in complex systems are examined. First, a conceptual framework is provided in which two broad categories of error are discussed: errors of action, or slips, and errors of intention, or mistakes. Conditions in which slips and mistakes might be expected to occur are identified, based on existing theories of human error. Regarding the role of workload, it is hypothesized that workload may act as a catalyst for error. Two experiments are presented in which humans' response to error-likely situations were examined. Subjects controlled PLANT under a variety of conditions and periodically provided subjective ratings of mental effort. A complex pattern of results was obtained, which was not consistent with predictions. Generally, the results of this research indicate that: (1) humans respond to conditions in which errors might be expected by attempting to reduce the possibility of error, and (2) adaptation to conditions is a potent influence on human behavior in discretionary situations. Subjects' explanations for changes in effort ratings are also explored.
Author

**N89-18394*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE EFFECT OF SIMULATED WEIGHTLESSNESS ON PERFORMANCE AND MOOD**
Bonnie Rosenberg *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 123-130 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 05I

# 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

**N89-18009#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.

**THE MAN-MACHINE INTERFACE IN TACTICAL AIRCRAFT DESIGN AND COMBAT AUTOMATION**

Jul. 1988 296 p In ENGLISH and FRENCH Symposium held in Stuttgart, Fed. Republic of Germany, 28 Sep. - 1 Oct. 1987 (AGARD-CP-425; ISBN-92-835-0471-2) Copyright Avail: NTIS HC A13/MF A01

Twenty-six unclassified papers of the 31 given at the symposium are presented. The papers were presented under the following headings: Combat scenarios and mission segment requirements; Human capabilities and limitations; Technological capabilities and limitations concerning situations awareness; Technological capabilities and limitations of combat automation; Crew station implementation, and System integration. For individual titles, see N89-18010 through N89-18034.

**N89-18010#** Test Wing (6510th), Edwards AFB, CA.

**MISSION PLANNING AND PROPER DESIGN: THE LONG RANGE CONNECTION**

Gary W. Matthes *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 4 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

Mission planning in tactical fighter operations is as important today as it was in any tactical operations of the past. The mission planner's task, whether performed by a pilot or a system operator, can be made easier and less susceptible to errors if designers understand the planners task and design to both move the workload to the planning room and minimize planning by proper choice of operational modes and aircraft sensors. There is a special connection between planning requirements and the design of the avionics suite to include its cockpit layout in a tactical fighter. However, this relationship should not be a simple function: i.e., cockpit workload should not decrease at the expense of ever increasing preflight workload. The move should always be to design cockpits and avionics that move as many functions as possible to the preflight planning room thus easing the pilots inflight duties and allowing him to focus on flying the craft and keeping abreast of the tactical situation. One man's opinion is presented of the importance of mission planning, now and in the future. This opinion was formed over 22 years of flying a wide variety of tactical fighters. Author

**N89-18011#** Defence Medical Services Directorate, London (England).

**HUMAN LIMITATIONS IN FLIGHT AND SOME POSSIBLE REMEDIES**

D. C. Reader *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 8 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

The biodynamic effects of high speed flight can produce sudden loss of consciousness without warning whereas most aircrew are used to the prodromal loss of vision. New advances in the anti G systems design can improve G tolerance but training is foreseen as the short term answer to this problem. Amongst the environmental stresses that limit performance are thermal, vibration, noise and NBC defence. Personal conditioning is of benefit under high thermal stress, active noise reduction can limit the reduction of noise at the ear and NBC defensive ensembles protect againt NBC agents. The design of the man machine interface can both enhance and detract from crew performance in flight. Head up displays, night goggles, helmet mounted displays, computer graphics, digital maps and integrated sensor displays can be viewed as new features which greatly increase mission capability. Finally, cockpit and system automation offers the chance of significant advances in cockpit design as management tasks can be completely relegated to the electronic crew member, leaving the human as the ultimate decision maker involved only when absolutely necessary. Author

**N89-18012#** School of Aerospace Medicine, Brooks AFB, TX.

**THE PILOT IS NOT THE LIMITING FACTOR IN HIGH PERFORMANCE AIRCRAFT**

R. R. Burton and W. C. Alexander *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 10 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

The physiologic requirements to validate a +G sub z tolerance model based on arterial pressure (Pa), eye-heart vertical distance (h), and hydrostatic pressure (P sub H) are investigated. Venous return (VR) and intrathoracic pressure (P sub I) are considered the major physiologic parameters involved in supporting this model at levels above 9 G. Venous return was determined to be adequate to support Pa during either relaxed lower level G tolerance or high sustained G. Some concern exists regarding VR during long duration G exposures, because of the delayed compliant nature of veins. P sub I, the physiologic basis for the anti G straining maneuver (AGSM), was found to be a function of inspiratory volume (V sub I); and therefore, as the subject is reclined to reduce h, the reduction in V sub I prevents a maximum AGSM limiting tolerance to 15 G. On the other hand, pilot pronation may not limit V sub I, and higher G tolerance may be possible. Fatigue was recognized as an important dimension of G tolerance and, as such, was examined as a limiting physiologic function at high sustained G. Primarily, because of the functional coupling between G-level and G-duration tolerances, if one is not G tolerance limiting, neither is the other. Author

**N89-18013#** British Aerospace Public Ltd. Co., Bristol (England).

**A MODEL TO PREDICT VISUAL PERFORMANCE AT THE MAN-DISPLAY INTERFACE IN THE COCKPIT**

Diana F. Johnson *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 8 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

Some of the problems are summarized which are typically encountered when viewing displays in the military cockpit. It is suggested that design and development of display configurations can be made quicker, cheaper, and more effective than present methods by using mathematical models of the man display interface to predict visual performance. The requirements for such models are discussed. A state of the art model which was developed at British Aerospace is reviewed. The model comprises spectral manipulation routines to calculate how the emission spectrum from a display is modified before reaching the eye, together with a psychophysical vision model which provides an objective measure of visibility. The benefits of using such a model are described. Finally, suggestions are made for future work to extend the present models. Author

**N89-18014#** Air Force Flight Test Center, Edwards AFB, CA.

**PILOT WORKLOAD ASSESSMENT: A FLIGHT TEST APPROACH**

Regina M. Papa and Janice R. Stoliker *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 12 p Previously announced in IAA as A88-38716 (For primary document see N89-18009 10-54)
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The present methodology for the assessment of the pilot workload effects of integration between a fighter aircraft and a specialized sensor augmentation system, with a view to the question of single seat cockpit effectiveness is described. It also allows the collection of subjective data pertinent to issues of cockpit controls and displays, situational awareness, task complexity,

surviability, and safety. Two different subjective workload metrics (supplemented by structured interviews) are used: the subjective workload assessment technique, and a modified Cooper-Harper type scale tailored for this application through the inclusion of a performance factor. E.R.

**N89-18015#** National Aerospace Lab., Amsterdam (Netherlands).
**CONSIDERATIONS CONCERNING THE ASSESSMENT OF PILOT WORKLOAD FOR COMPLEX TASK CONDITIONS**
R. C. vandeGraaff *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 15 p (For primary document see N89-18009 10-54)
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Workload research has led to the development of various measures, mostly concerning difference aspects of task workload. A number of ways concerning the problem of being able to draw conclusions from a variety of experimental measures in a complex task situation are discussed. Several implications are pointed out, such as the problem of dealing with contradictory outcomes, the designating of artefacts, and the problem of formulating final conclusions without the availability of a superior method for evaluating other methods. These considerations were examined in detail in an inflight study concerning the assessment of pilot workload under various instrument approach conditions. The findings are compared with the results of a former inflight experiment dealing with pilot workload. A discussion is given of the results consisting of subjective ratings, physiological measures, and task performance measures. A strategy is discussed dealing with the formulation of final conclusions. Author

**N89-18016#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
**ADVANCES IN WORKLOAD MEASUREMENT FOR COCKPIT DESIGN EVALUATION**
Maris M. Vikmanis *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 10 p (For primary document see N89-18009 10-54)
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The stressful mission environment for tactical aircraft in the 1990's will require improved integration of pilot and machine to assure successful operations. Research has focused on the development of quantitative pilot performance and workload measures. Improved methods for defining pilot functions, tasks, and performance variables were developed along with test design and data analysis techniques to support cockpit evaluations. Significant advances in the measurement of workload were made using subjective and neurophysiological techniques. Research on measures of pilot situation awareness and decision making, critical toward understanding the pilot interface with automated systems, is underway. The approach has been to establish a solid base of lab research followed by the test and evaluation of measurement techniques in complex flight simulators and then actual flight experiments. Author

**N89-18017#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Helicopter and Military Aircraft Group.
**MODING STRATEGY FOR COCKPIT DATA MANAGEMENT IN MODERN FIGHTER AIRCRAFT**
R. Seifert and H. Neujahr *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 8 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

A method for moding strategy of cockpit data management in fighter aircraft has been extended to include assessment of access time allowed for information elements and control and differentiation of the mission tasks according to demand type (importance, frequency of use). This method developed so far renders the operational requirement for the cockpit moding. The steps of specifying the cockpit moding are as yet not so well defined. That is why the term moding strategy is used instead of method in the title. The method of deriving the operational requirements and the subsequent tasks to be performed within the process of cockpit moding are examined. The design driving mission is not detailed. The criteria applicable to define and breakdown missions in different scenarios are dealt with elsewhere. Author

**N89-18018#** Aeritalia S.p.A., Caselle Torinese (Italy). Gruppo Sistemi Avionici ed Equipaggiamenti.
**A MAN-MACHINE INTERFACE SOLUTION: THE EAP GLARE SHIELDS**
Luigino Bonetto and Gianfranco Terrando *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 9 p (For primary document see N89-18009 10-54)
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Continuous improvements in capabilities of military aircrafts require sophisticated navigation, communication and weapon systems. In the mean time pilots are required to interact with these systems by using data entry facilities or synthetic data displays. Control panels using traditional push buttons with fixed legend cannot be flexible enough to meet these new requirements. An original solution is presented to control the systems through an integrated alphanumeric keyboard facility using custom push botton matrix with programmable LED display legend. Design and development activities were carried out; two pieces of equipment named LEFT and RIGHT GLARE SHIELDS are now operational on the EAP demonstrator. Author

**N89-18019#** Air Force Avionics Lab., Wright-Patterson AFB, OH.
**PANORAMIC COCKPIT CONTROL AND DISPLAY SYSTEM (PCCADS)**
N. Schwartz and Eugene Adam (McDonnell Aircraft Co., St. Louis, MO.) *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 10 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

A real time, pilot interactive demonstration and test of a large area fighter cockpit display was conducted. The test of this large area, full color display was conducted in a mock-up cockpit at a simulation facility. This display used essentially the entire instrument panel area to present a moving map with symbology and other information overlain and also presented sensor imagery and other information as required. The information presented could be customized for a particular mission phase or other need. A touch sensitive display as well as other advanced control concepts were also demonstrated in conjunction with the large area display. This display and control concept simplifies and automates many of the control and display functions for the pilot of an advanced fighter aircraft. The results of demonstration and testing with ten pilots are presented. Author

**N89-18020#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
**MULTISENSOR TARGET RECONNAISSANCE**
G. Bauer *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 5 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

An example of the concept of a knowledge based sensor fusion system is presented, which combines a radar primary sensor with an IR secondary sensor. The radar's wide range of view is used for Target Recognition over a large area, while the IR sensor's high resolution at a small angle of aperture is employed for target classification. Author

**N89-18021#** Centre d'Enseignement et de Recherches de Medecine Aeronautique, Paris (France).
**PILOTS AS SUPERVISORS AND MANAGERS OF AUTOMATIC SYSTEMS: A RISKY NEW FACTOR IN MAN-MACHINE SYSTEMS RELIABILITY [PILOTES SUPERVISEURS ET GESTIONNAIRES DE SYSTEMES AUTOMATIQUES UN NOUVEAU ROLE BIEN RISQUE POUR LA FIABILITE DU COUPLE HOMME-MACHINE]**
R. Amalberti *In* AGARD, The Man-Machine Interface in Tactical

Aircraft Design and Combat Automation Jul. 1988 8 p In FRENCH (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

The evolution of the man-machine task related to automized airborne systems is discussed. Cognitive functioning in control processes, information acquisition, and modifications of pilot tasks are addressed. Author

**N89-18022#** Dassault-Breguet Aviation, St. Cloud (France).
**EXPERT SYSTEM MAN-MACHINE INTERFACE FOR A COMBAT AIRCRAFT COCKPIT**
Jean Saulais and Pierre Larroque *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 7 p In FRENCH; ENGLISH summary (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

Through developing navigation and attack systems on combat aircraft and by analyzing the new operational concepts, an ever increasing workload is required from the pilot. An important part of the workload lies in getting the management information to the pilot. In case of very low level flying, getting this information becomes especially tight; the pilot cannot divert his attention from outside the cockpit to watch over the vehicle and its systems. For this reason, modern fighter cockpit are already oriented toward using head-up terminals for displaying built-up information. Enhancements were made on displays in order to increase the capacity of collimated data. In addition, synthetic voice warnings are already used and day after day, the pace of speech processing is increasing. Expert systems are being studied for the purpose of operating at two levels, depending both on its importance with respect to the mission and on the workload inferred by the expert system in the different steps of the mission. Author

**N89-18023#** Centre d'Essais en Vol, Istres (France).
**LESSONS LEARNED FROM THE USE OF NEW COMMAND SYSTEMS [ENSEIGNEMENTS TIRES DE LUTILISATION DE NOUVEAUX SYSTEMES DE COMMANDE]**
Jacques Rosay *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 7 p In FRENCH (For primary document see N89-18009 10-54)
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The general informatization of combat aircraft has allowed the introduction of radically new cabin architectures and command systems. In these new interfaces, the information that is exchanged between the pilot and machine can undergo processing and take on various forms. The range of possibilities for these processing techniques and forms is vitually limitless. Experiences in the use of certain system elements -- screens, control boards, voice command systems, and ergonomically adapted displays are discussed along with various physical and mental human-factors considerations. Author

**N89-18024#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH. Visual Display Systems Branch.
**DESIGN CONSIDERATIONS FOR VIRTUAL PANORAMIC DISPLAY (VPD) HELMET SYSTEMS**
Dean F. Kocian *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 32 p (For primary document see N89-18009 10-54)
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Some of the fundamental performance and design parameters that should be considered for the successful evolution and integration of a new type of helmet mounted display (HMD) system intended for use in the military aircraft cockpits are described. It is called a virtual panoramic display (VPD). The parameters discussed include field-of-view, exit pupil, image quality, eye relief, collimation, alignment, size, weight, system integration, etc. For the first time the associated helmet system is considered as an integral subsystem that must be designed to support the requirements of the HMD. Trade-offs relating to the intended VPD applications, HMD design and its impact on the associated image source and display electronics are discussed. Design issues and considerations are developed primarily from the viewpoint of the VPD system integrator. Author

**N89-18025#** British Aerospace Aircraft Group, Preston (England). Military Aircraft Division.
**TOWARDS THE NEXT GENERATION FIGHTER COCKPIT: THE EAP EXPERIENCE**
Katharine M. Wykes and Maurizio Spinoni (Aeritalia S.p.A., Turin, Italy ) *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 18 p (For primary document see N89-18009 10-54)
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The main design is outlined of the cockpit of the Experimental Aircraft Program (EAP) aircraft. The structured design process that was followed is described. The main features of the resulting cockpit are outlined, together with some of the rationale behind their design. These include: (1) Display moding: how the format hierarchy is managed, how the formats were constructed and how color has been used on the displays; (2) The hands on throttle and stick concept and how this applies to the EAP; (3) A manual data entry facility capable of controlling ten different subsystems through totally multifunction devices; and (4) An intelligent warning system based on the use of a digitized voice. These facilities have been flying for over a year now and the experience gained during their design and subsequent flight testing is helping to form the basis for the European Fighter Aircraft cockpit design. Author

**N89-18026#** British Aerospace Public Ltd. Co., Brough (England).
**PILOT INTEGRATION AND THE IMPLICATIONS ON THE DESIGN OF ADVANCED COCKPITS**
R. S. Kalawsky *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 16 p (For primary document see N89-18009 10-54)
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A totally enclosed cockpit may quickly become the driving factor for the next generation of tactical fighter aircraft and will deny access to the pilot of essential outside world cues. Also, the number of sensory systems carried aboard the aircraft is inceasing, with the threat of unacceptable pilot workload. Pilot and aircraft reaction times may be a decisive factor in any conflict situation in the future, so the pilot must have a greater situation awareness than ever before. The future cockpit designer must have a greater appreciation and awareness of the human factors related issues, and tailor system performance to match human performance limits. The cockpit situation is assessed and how the pilot can be successfully integrated with newly emerging technologies to overcome the problems introduced by a closed cockpit philosophy and increased workload is examined. An insight into one possible cockpit solution is studied. Author

**N89-18027#** Dornier-Werke G.m.b.H., Friedrichshafen (Germany, F.R.).
**PILOT CONTROL DEVICES**
W. Fuchs, R. Kodweiss, and M. Weidel *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 13 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

Advanced cockpit design requires geometry improvements to accommodate greater pilot percentile ranges, to reduce pilot fatigue and discomfort, to increase G-load resistance and to allow a different ejection path. Simulator trials were performed to optimize the installation positions of control devices for different seat angles, the control parameters including gain and force gradients as well as the use of force and displacement signals. The simulator results will be scaled down for inflight use. Adaptive gain shaping and a reduction of control force using higher controller damping were tested. A method for reducing the risk of loss of consciousness and means to increase pilot efficiency is discussed. Author

**N89-18028#** Technische Hogeschool, Delft (Netherlands). Faculty of Aerospace Engineering.
**ACTIVE AND PASSIVE SIDE STICK CONTROLLERS: TRACKING TASK PERFORMANCE AND PILOT CONTROL BEHAVIOUR**
R. J. A. W. Hosman and J. C. vanderVaart *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 11 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

A servo controlled side stick featuring hydraulic actuators with hydrostatic bearings was developed. Due to its smooth operation, low noise characteristics and high bandwidth, a great variety of dynamic characteristics can be simulated. This research tool can very conveniently be used as a conventional passive stick to assess the desired side stick dynamics for future fly by wire aircraft. Still more important is that with a servo controlled side stick, stick force and stick displacement can be controlled virtually independent. This feature can be used for experimental research to investigate the perception and feedback of stick force and stick displacement by the pilot's neuromuscular system in the control task. After a short description of the side stick controller hardware, results of a tracking experiment in a moving base flight simulator is presented. Considerable improvement in tracking performance and significant changes of measured pilot control behavior were found for the active when conpared to the passive control stick. Author

**N89-18029#** National Research Council of Canada, Ottawa (Ontario). Flight Research Lab.
**THE USE OF INTEGRATED SIDE-ARM CONTROLLERS IN HELICOPTERS**
J. M. Morgan and S. R. M. Sinclair *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 11 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

Research conducted with integrated side stick controllers in a variable stability helicopter is reviewed. The investigations involve the use of three different types of controllers. The advantages and disadvantages of integrated controllers are discussed and an informed opinion of their applicability is presented. Finally, data acquired during a succession of piloted experiments, indicating that Level 1 handling qualities are achievable with these types of controllers, are summarized. Author

**N89-18030#** Boeing Helicopter Co., Philadelphia, PA.
**ADVANCED FLIGHT CONTROL SYSTEM FOR NAP-OF-THE-EARTH FLIGHT**
Steven I. Glusman, Charles Dabundo, and Kenneth H. Landis *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 15 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

A digital/optical flight control system was implemented on a UH-60 Black Hawk helicopter to determine flight control system requirements for Nap-of-the-Earth (NOE) flight. Small-displacement side stick controllers with unique force trim positions were an integral part of the control system design. Controller configurations could be readily altered from a fully integrated 4-axis side stick controller to separated controller and configurations including (3+1) collective and (2+1+1). Control laws were implemented with a model following architecture that facilitates variation of control response characteristics. The Automatic Flight Control System was designed to provide level 1 handling qualities and the Primary Flight Control System was implemented to achieve level 2 handling qualities. The interrelational effects of controller configuration and piloting task on handling qualities was investigated. Handling qualities were evaluated using precision hover and low speed tasks typical of NOE flights as well as tasks performed at airspeeds from 80 to 120 knots. Piloted results are presented with recommendations for future systems. Author

**N89-18031#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH. Human Engineering Div.
**MATCHING CREW SYSTEM SPECIFICATIONS TO HUMAN PERFORMANCE CAPABILITIES**
Kenneth R. Boff *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 9 p (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

Despite spectacular advances in display systems and data handling technologies, modern crew systems confront their operators with a large volume of codified information which competes for scarce attentional and control resources. Achieving an optimal fit between system capabilities and the perceptual and performance characteristics of the operator requires the presence of at least three elements: (1) Usable data resources, human performance data; (2) An effective interface providing methods and media to support accession and evaluation of these data; and (3) Sophisticated and Motivated users. Designing for active presence of these elements requires understanding of and assumes some ability to influence individual, organizational and regulatory variables that jointly support the design and acquisition processes. Author

**N89-18032#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
**INTEGRATED CONTROL AND AVIONICS FOR AIR SUPERIORITY**
James A. Kocher *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 7 p (For primary document see N89-18009 10-54)
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The Integrated Control and Avionics for Air Superiority (ICAAS) Program is a program to develop, design, and demonstrate selected fighter aircraft technologies needed to kill and survive when outnumbered in air combat engagements. Design emphasis is placed upon functional integration of sensors, fire control, flight control, weapons and interface with the pilot to achieve improved close-in combat. Details of the ICAAS concept and design approach are presented. Author

**N89-18033#** Air Force Flight Test Center, Edwards AFB, CA.
**AFTI/F-16 IMPACT OF COCKPIT AUTOMATION ON PILOT ACCEPTANCE**
Mark A. Stubben *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul. 1988 10 p (For primary document see N89-18009 10-54)
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The Advanced Fighter Technology Integration (AFTI) F-16 Joint Test Force recently completed a developmental flight test program investigating a fully automated weapons delivery system. The F-16 boasted an impressive array of automatic systems that increased the effectiveness of both the pilot and airframe as an overall weapon system. The highly modified F-16 testbed was fitted with a digital flight control system, a conformally mounted infrared sensor/laser ranging pod, integrated fire/flight control computers, a digital color moving map, and a voice recognition system. The AFTI/F-16 integrated these sensors, avionics, and flight control systems into an Automated Maneuvering and Attack System (AMAS), capable of full authority automatic air to surface weapons delivery with profiles down to 200 ft above ground level. Test results of the developmental flight test program are presented and an assessment is provided of the individual AMAS subsystems on the overall workload of the pilot and the pilot acceptance of a fully automated weapons delivery system. Author

**N89-18034#** Army Aviation Systems Command, Moffett Field, CA. Aeroflightdynamics Directorate.
**ADVANCED HELICOPTER COCKPIT AND CONTROL CONFIGURATIONS FOR HELICOPTER COMBAT MISSION TASKS**
Loran A. Haworth, Adolph Atencio, Jr., Courtland Bivens, Robert Shively, and Daniel Delgado *In* AGARD, The Man-Machine Interface in Tactical Aircraft Design and Combat Automation Jul.

1988 16 p Previously announced as N88-14988 (For primary document see N89-18009 10-54)
Copyright Avail: NTIS HC A13/MF A01

Two piloted simulations were conducted by the U.S. Army Aeroflightdynamics Directorate to evaluate workload and helicopter-handling qualities requirements for single pilot operation in a combat Nap-of-the-Earth environment. The single pilot advanced cockpit engineering simulation (SPACES) investigations were performed on the NASA Ames Vertical Motion Simulator, using the Advanced Digital Optical Control System control laws and an advanced concepts glass cockpit. The first simulation (SPACES I) compared single pilot to dual crewmember operation for the same flight tasks to determine differences between dual and single ratings, and to discover which control laws enabled adequate and single pilot helicopter operation. The SPACES II simulation concentrated on single pilot operations and use of control laws thought to be viable candidates for single pilot operations workload. Measures detected significant differences between single pilot task segments. Control system configurations were task dependent, demonstrating a need for inflight reconfigurable control system to match the optimal control system with the required task. Author

**N89-18035*#** Old Dominion Univ., Norfolk, VA.
**MARS OXYGEN PRODUCTION SYSTEM DESIGN**
Charles E. Cotton, Linda K. Pillow, Robert C. Perkinson, R. P. Brownlie, P. Chwalowski, M. F. Carmona, J. P. Coopersmith, J. C. Goff, L. L. Harvey, and L. A. Kovacs et al 8 Feb. 1989 7 p Presented at the 4th Annual NASA/USRA Design Review University Advanced Design Program Conference, Cocoa Beach, FL, 14-17 Jun. 1988 Prepared in cooperation with NASA. Lyndon B. Johnson Space Center, Houston, TX
(Grant NGT-21-002-080)
(NASA-CR-184752; NAS 1.26:184752) Avail: NTIS HC A02/MF A01 CSCL 06K

The design and construction phase is summarized of the Mars oxygen demonstration project. The basic hardware required to produce oxygen from simulated Mars atmosphere was assembled and tested. Some design problems still remain with the sample collection and storage system. In addition, design and development of computer compatible data acquisition and control instrumentation is ongoing. Author

**N89-18036** National Physical Lab., Teddington (England). Div. of Radiation Science and Acoustics.
**INTERCOMPARISON OF MEASUREMENTS ON EAR PROTECTORS BY SUBJECTIVE AND OBJECTIVE TEST METHODS (NPL RESULTS)**
M. S. Shipton Sep. 1987 82 p
(NPL-AC-115; ISSN-0143-7143; ETN-89-93707) Copyright Avail: National Physics Laboratory, Teddington, Middlesex, TW11 0LW, United Kingdom

An intecomparison involving five laboratories was carried out to quantify and identify the origin of discrepancies involved in measuring the attenuation of five different types of hearing protector using subjective and objective procedures. The test methods and the detailed results obtained on muffs and plugs are presented. ESA

**N89-18037*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**PILOTS' USE OF A TRAFFIC ALERT AND COLLISION-AVOIDANCE SYSTEM (TCAS 2) IN SIMULATED AIR CARRIER OPERATIONS. VOLUME 1: METHODOLOGY, SUMMARY AND CONCLUSIONS**
Sheryl L. Chappell, Charles E. Billings, Barry C. Scott, Robert J. Tuttell, M. Christine Olsen, and Thomas E. Kozon (Sterling Software, Palo Alto, CA.) Jan. 1989 40 p
(NASA-TM-100094-Vol-1; A-88140; NAS 1.15:100094-Vol-1)
Avail: NTIS HC A03/MF A01 CSCL 05H

Pilots' use of and responses to a traffic alert and collision-avoidance system (TCAS 2) in simulated air carrier line operations are described in Volume 1. TCAS 2 monitors the positions of nearby aircraft by means of transponder interrogation, and it commands a climb or descent when conflicting aircraft are projected to reach an unsafe closest point-of-approach within 20 to 25 seconds. A different level of information about the location of other air traffic was presented to each of three groups of flight crews during their execution of eight simulated air carrier flights. A fourth group of pilots flew the same segments without TCAS 2 equipment. Traffic conflicts were generated at intervals during the flights; many of the conflict aircraft were visible to the flight crews. The TCAS equipment successfully ameliorated the seriousness of all conflicts; three of four non-TCAS crews had hazardous encounters. Response times to TCAS maneuver commands did not differ as a function of the amount of information provided, nor did response accuracy. Differences in flight experience did not appear to contribute to the small performance differences observed. Pilots used the displays of conflicting traffic to maneuver to avoid unseen traffic before maneuver advisories were issued by the TCAS equipment. The results indicate: (1) that pilots utilize TCAS effectively within the response times allocated by the TCAS logic, and (2) that TCAS 2 is an effective collision avoidance device. Volume II contains the appendices referenced in Volume I, providing details of the experiment and the results, and the text of two reports written in support of the program. Author

**N89-18038*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**PILOTS' USE OF A TRAFFIC ALERT AND COLLISION-AVOIDANCE SYSTEM (TCAS 2) IN SIMULATED AIR CARRIER OPERATIONS. VOLUME 2: APPENDICES**
Sheryl L. Chappell, Charles E. Billings, Barry C. Scott, Robert J. Tuttell, M. Christine Olsen, and Thomas E. Kozon (Sterling Software, Palo Alto, CA.) Jan. 1989 126 p
(NASA-TM-100094-Vol-2; A-88140; NAS 1.15:100094-Vol-2)
Avail: NTIS HC A07/MF A01 CSCL 05H

Pilots' use of and responses to a traffic alert and collision-avoidance system (TCAS 2) in simulated air carrier line operations are discribed in Volume 1. TCAS 2 monitors the positions of nearby aircraft by means of transponder interrogation, and it commands a climb or descent which conflicting aircraft are projected to reach an unsafe closest point-of-approach within 20 to 25 seconds. A different level of information about the location of other air traffic was presented to each of three groups of flight crews during their execution of eight simulated air carrier flights. A fourth group of pilots flew the same segments without TCAS 2 equipment. Traffic conflicts were generated at intervals during the flights; many of the conflict aircraft were visible to the flight crews. The TCAS equipment successfully ameliorated the seriousness of all conflicts; three of four non-TCAS crews had hazardous encounters. Response times to TCAS maneuver commands did not differ as a function of the amount of information provided, nor did response accuracy. Differences in flight experience did not appear to contribute to the small performance differences observed. Pilots used the displays of conflicting traffic to maneuver to avoid unseen traffic before maneuver advisories were issued by the TCAS equipment. The results indicate: (1) that pilots utilize TCAS effectively within the response times allocated by the TCAS logic, and (2) that TCAS 2 is an effective collision avoidance device. Volume 2 contains the appendices referenced in Volume 1, providing details of the experiment and the results, and the text of two reports written in support of the program. Author

**N89-18039*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**INTERACTIVE ORBITAL PROXIMITY OPERATIONS PLANNING SYSTEM**
Arthur J. Grunwald and Stephen R. Ellis Nov. 1988 48 p
(NASA-TP-2839; A-88091; NAS 1.60:2839) Avail: NTIS HC A03/MF A01 CSCL 05H

An interactive graphical proximity operations planning system was developed, which allows on-site design of efficient, complex, multiburn maneuvers in a dynamic multispacecraft environment. Maneuvering takes place in and out of the orbital plane. The difficulty in planning such missions results from the unusual and

counterintuitive character of orbital dynamics and complex time-varying operational constraints. This difficulty is greatly overcome by visualizing the relative trajectories and the relevant constraints in an easily interpretable graphical format, which provides the operator with immediate feedback on design actions. The display shows a perspective bird's-eye view of a Space Station and co-orbiting spacecraft on the background of the Station's orbital plane. The operator has control over the two modes of operation: a viewing system mode, which enables the exporation of the spatial situation about the Space Station and thus the ability to choose and zoom in on areas of interest; and a trajectory design mode, which allows the interactive editing of a series of way points and maneuvering burns to obtain a trajectory that complies with all operational constraints. A first version of this display was completed. An experimental program is planned in which operators will carry out a series of design missions which vary in complexity and constraints. Author

**N89-18040#** California Univ., Santa Barbara.
**MOTOR RESPONSES TO OBJECTS: PRIMING AND HAND SHAPING Annual Technical Report, 1 Jul. 1987 - 1 Jul. 1988**
Roberta A. Klatzky and James W. Pelligrino 20 Sep. 1988 39 p
(Grant AF-AFOSR-0230-87; AF Proj. 2313)
(AD-A200633; AFOSR-88-1167TR) Avail: NTIS HC A03/MF A01 CSCL 05H

This research deals with motor responses to common objects and with the cognitive representations of such responses. A priming would facilitate judgements about the sensibility of actions performed with objects. Primes pertained to: (1) the size of the functional hand shape, and/or (2) whether the hand acted as a prehensile or nonprehensile instrument. Priming was found to be effective when both these features were specified and training on the prime signal required that the shape be explicitly enacted. Partial primes and training of verbal responses to the signal were effective. Examination of actual manual responses to objects indicates that interactions involving different hand shapes have a common timecourse during reaching and preshaping until relatively late, when the precision of the ultimate motor act differentiates among large and small, and prehensile versus nonprehensile, shapes. GRA

**N89-18041#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**A BEHAVIOR-BASED ARM CONTROLLER**
Jonathan H. Connell Jun. 1988 16 p
(Contracts N00014-86-K-0685; N00014-85-K-0124)
(AD-A200666; AI-M-1025) Avail: NTIS HC A03/MF A01 CSCL 12I

In this paper we describe a working, implemented controller for a real, physical mobile robot arm. The controller is composed of a collection of 15 independent behaviors which run, in real time, on a set of eight loosely-coupled on-board 8-bit microprocessors. We describe how these behaviors cooperate to actually seek out and retrieve objects using local sensory data. We also discuss the methodology used to decompose this collection task and the types of spatial representation and reasoning used by the system. GRA

**N89-18042#** Essex Corp., Alexandria, VA.
**HUMAN-MACHINE INTERFACES IN INDUSTRIAL ROBOTICS Final Report**
H. M. Parsons and Anne S. Mavor Sep. 1988 119 p
(DA Proj. 1L66-5502-MM-40)
(AD-A200960; HEL-TM-7-88) Avail: NTIS HC A06/MF A01 CSCL 23B

This report surveys human-machine interfaces in industrial robotics. Its aim is to create a data base concerning design practices in equipment and software pertaining to human factors engineering, with a summary of programming features and a taxonomy of programming tasks. It results from a study of ten robot manufacturers (eight American, one Swedish, one Japanese), plus a more limited review of another Japanese manufacturer. The equipment surveyed falls into three categories: teach pendants, cathode-ray tube (CRT/keyboard terminals), and controller panels; the software consists primarily of the languages and procedures for programming robots on the factory floor as well as in applications programming off-line. The first section reviews aspects relating to programming design from a human factors viewpoint. The second part outlines the component tasks in programming a robot and the uses of these taxonomic descriptions. The Appendix describes in detail the designs in these hardware and software categories for each robot manufacturer and contains illustrations. GRA

**N89-18043#** Navy Clothing and Textile Research Facility, Natick, MA.
**KYNOL/NOMEX FABRICS FOR FIRE RETARDANT SHIPBOARD UTILITY UNIFORMS Final Report, Jan. 1984 - Jan. 1985**
Richard D. Wojtaszek and Norman F. Audet Jun. 1988 188 p
(AD-A201011; NCTRF-165) Avail: NTIS HC A09/MF A01 CSCL 11E

At the request of the Naval Sea Systems Command, the Navy Clothing & Textile Research Facility (NCTRF) conducted a seven-phase investigation of Kynol/Nomex fabrics for possible use in Fire-Retardent (FR) shipboard utility uniforms in place of Fire-Retardent-Treated (FRT) cotton. NCTRF first surveyed the U.S. protective clothing market and then tested three Kynol/Nomex blends in its laboratories to determine their physical, abrasion resistance, and laundering properties. Meanwhile, NCTRF ran physiological tests to show the heat stress imposed by the various uniforms and conducted a full array of heat tests ranging from laboratory tests for heat and flame resistance to full-scale flame-envelopment and close-proximity fire tests. NCTRF also administered a shipboard evaluation and subsequently conducted a dyeing and finishing study. Finally, NCTRF completed a cost evaluation of these uniforms. Because these Kynol/Nomex uniforms showed no significant functional heat-resistant benefits over FRT cotton and would cost at least twice as much, NCTRF recommended the Navy continue using FRT cotton for the FR shipboard utility uniforms. GRA

**N89-18044#** Navy Clothing and Textile Research Facility, Natick, MA.
**MICROCLIMATE COOLING SYSTEMS: A PHYSIOLOGICAL EVALUATION OF TWO COMMERCIAL SYSTEMS Final Technical Report, Apr. - Oct. 1987**
Nancy A. Pimental, Barbara A. Avellini, and Carl R. Janik Jun. 1988 27 p
(AD-A201139; NCTRF-164) Avail: NTIS HC A03/MF A01 CSCL 05H

The Navy Clothing and Textile Research Facility (NCTRF) conducted a laboratory evaluation to compare two commercially available, portable, liquid microclimate cooling systems for their effectiveness in reducing heat stress and for their operational characteristics. The systems were the Model 1905 Cool Vest manufactured by ILC Dover, Inc. (ILC), and the Cool Head manufactured by Life Support Systems, Inc. (LSSI). The two systems were evaluated on nine test subjects wearing the Navy utility uniform and performing light-to-moderate exercise for 3 hours in an environment of 43 C dry bulb, 29 C dew point (WBGT 36 C). Compared with a control test with no cooling, use of either cooling system enabled subjects to complete the 3-hour heat exposures. Rectal temperature responses were the same when either cooling system was used. Heart rates were slightly lower with the ILC Dover system compared to the LSSI system. The ILC systems experienced fewer failures, and were easier to operate than the LSSI systems. The ILC system is also lighter, less bulky, and much less expensive than the LSSI system. Based on their similarity in reducing heat stress, and the ILC Dover system's profile, reliability and lower cost, the ILC Dover Model 1905 Cool Vest system is recommended over the Cool Head for Navy use. This report describes the two cooling systems and the results of the heat stress evaluation. GRA

**N89-18379*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**LIVING AND WORKING IN SPACE**
Linda Armstrong *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 1-8 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 05H

**N89-18391*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**PILOT PERFORMANCE**
Jennifer Nicholls *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 105-111 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 05H

**N89-18404*#** National Aeronautics and Space Administration, Washington, DC.
**HUMAN FACTORS: AERONAUTICS**
James P. Jenkins *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 147-177 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 05H

**N89-18405*#** National Aeronautics and Space Administration, Washington, DC.
**HUMAN FACTORS: SPACE**
James P. Jenkins *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 179-201 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 05H

# 55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

No abstracts in this category.

# 59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

**N89-18045*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**SYSTEMS AUTONOMY TECHNOLOGY: EXECUTIVE SUMMARY AND PROGRAM PLAN**
John S Bull, ed. Dec. 1987 167 p Prepared in cooperation with NASA. Goddard Space Flight Center, Greenbelt, MD; JPL, Calif., Inst. of Tech., Pasadena; Johnson Space Center; Kennedy Space Center; Langley Research Center; Lewis Research Center and Marshall Space Flight Center
(NASA-TM-100999; A-88174; NAS 1.15:100999) Avail: NTIS HC A08/MF A01 CSCL 09B

The National Space Strategy approved by the President and Congress in 1984 sets for NASA a major goal of conducting effective and productive space applications and technology programs which contribute materially toward United States leadership and security. To contribute to this goal, OAST supports the Nation's civil and defense space programs and overall economic growth. OAST objectives are to ensure timely provision of new concepts and advanced technologies, to support both the development of NASA missions in space and the space activities of industry and other organizations, to utilize the strengths of universities in conducting the NASA space research and technology program, and to maintain the NASA centers in positions of strength in critical space technology areas. In line with these objectives, NASA has established a new program in space automation and robotics that will result in the development and transfer and automation technology to increase the capabilities, productivity, and safety of NASA space programs including the Space Station, automated space platforms, lunar bases, Mars missions, and other deep space ventures. The NASA/OAST Automation and Robotics program is divided into two parts. Ames Research Center has the lead role in developing and demonstrating System Autonomy capabilities for space systems that need to make their own decisions and do their own planning. The Jet Propulsion Laboratory has the lead role for Telerobotics (that portion of the program that has a strong human operator component in the control loop and some remote handling requirement in space). This program is intended to be a working document for NASA Headquarters, Program Offices, and implementing Project Management. Author

# 60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

**N89-18046*#** Illinois Univ., Urbana-Champaign. Coordinated Science Lab.
**IMPACT OF DEVICE LEVEL FAULTS IN A DIGITAL AVIONIC PROCESSOR**
Ho Kim Suk Jan. 1989 55 p
(Grant NAG1-602)
(NASA-CR-184783; NAS 1.26:184783; UILU-ENG-89-2210; CSG-99) Avail: NTIS HC A04/MF A01 CSCL 09B

This study describes an experimental analysis of the impact of gate and device-level faults in the processor of a Bendix BDX-930 flight control system. Via mixed mode simulation, faults were injected at the gate (stuck-at) and at the transistor levels and, their propagation through the chip to the output pins was measured. The results show that there is little correspondence between a stuck-at and a device-level fault model, as far as error activity or detection within a functional unit is concerned. In so far as error activity outside the injected unit and at the output pins are concerned, the stuck-at and device models track each other. The stuck-at model, however, overestimates, by over 100 percent, the probability of fault propagation to the output pins. An evaluation of the Mean Error Durations and the Mean Time Between Errors at the output pins shows that the stuck-at model significantly underestimates (by 62 percent) the impact of an internal chip fault on the output pins. Finally, the study also quantifies the impact of device fault by location, both internally and at the output pins. Author

**N89-18047*#** Illinois Univ., Urbana-Champaign. Coordinated Science Lab.
**A PARALLEL ROW-BASED ALGORITHM WITH ERROR CONTROL FOR STANDARD-CELL REPLACEMENT ON A HYPERCUBE MULTIPROCESSOR**
Jeff Scott Sargent Dec. 1988 78 p
(Grant NAG1-613)
(NASA-CR-184778; NAS 1.26:184778; UILU-ENG-88-2259; CSG-92) Avail: NTIS HC A05/MF A01 CSCL 09B

A new row-based parallel algorithm for standard-cell placement targeted for execution on a hypercube multiprocessor is presented. Key features of this implementation include a dynamic simulated-annealing schedule, row-partitioning of the VLSI chip image, and two novel new approaches to controlling error in parallel cell-placement algorithms; Heuristic Cell-Coloring and Adaptive (Parallel Move) Sequence Control. Heuristic Cell-Coloring identifies sets of noninteracting cells that can be moved repeatedly, and in parallel, with no buildup of error in the placement cost. Adaptive Sequence Control allows multiple parallel cell moves to take place between global cell-position updates. This feedback mechanism is based on an error bound derived analytically from the traditional

annealing move-acceptance profile. Placement results are presented for real industry circuits and the performance is summarized of an implementation on the Intel iPSC/2 Hypercube. The runtime of this algorithm is 5 to 16 times faster than a previous program developed for the Hypercube, while producing equivalent quality placement. An integrated place and route program for the Intel iPSC/2 Hypercube is currently being developed. Author

**N89-18048#** Research Inst. of National Defence, Linkoeping (Sweden). Dept. of Information Technology.
**INTERFACE TO HANDLE AN OPTICAL DISK**
Anders Alm Jul. 1988 28 p In SWEDISH; ENGLISH summary
(FOA-C-30502-3.3; ISSN-0347-3708; ETN-89-93742) Avail: NTIS HC A03/MF A01; Swedish Defense Research Establishment, Box 1165, S-581 11 Linkoping, Sweden, 50 Swedish crowns

The design of an interface between an optical disk with SCSI (small computer systems interface) connection and a computer with VME connection is reported, including programs for filehandling, the monitor, and for a single circuit board computer. Logic file structure and physical file structure are dealt with. The function of the different routines (basic and auxiliary) are described, and the way to call for one of them is explained. ESA

**N89-18049#** New York Univ., New York. Inst. of Mathematical Sciences.
**ULTRACOMPUTER PROGRESS, 1988**
1988 9 p
(Contract DE-FG02-88ER-25052)
(DE89-004863; DOE/ER-25052/1) Avail: NTIS HC A02/MF A01

This paper discusses progress on the ultracomputer project in the following areas: operating systems, debugging, algorithms, environment, network simulation, analytical modeling of network behavior, random number generation for parallel computers, architecture, applications, and programming language design. DOE

**N89-18050#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**A MEMORY DESIGN FOR THE MESSAGE-DRIVEN PROCESSOR**
Soha M. Hassoun Aug. 1988 89 p
(Contracts N00014-80-C-0622; N00014-87-K-0825)
(AD-A200781; VLSI-MEMO-88-465) Avail: NTIS HC A05/MF A01 CSCL 12F

The Message-Driven Processor (MDP) is a low-latency processing node for a scalable fine-grain MIMD concurrent computer, the Jellybean Machine. Programs are executed by passing messages through a low-latency network. Each MDP integrates a processor, a memory, and a communication network. On top of this message-passing model, the MDP supports a global virtual address space. This thesis involves the design and implementation of a memory for the Message-Driven Processor. The memory array can be accessed by index, by row, or as a set-associative cache. Index operations are used to read and write memory. Row operations reduce the latency in message-handling by providing special purpose buffers, Row Buffers that access four words (a row) of memory simultaneously. Two Queue Row Buffers enable buffering message at two different priority levels as soon as they arrive from the network. An Instruction Row Buffer acts as a small instruction cache. Set-associative operations provide a translation mechanism to enable translating any object to its associated item. MDP operating system routines use this cache to translate virtual identifiers into global addresses. The microarchitecture and the circuit design of the memory is developed. A test chip is fabricated to verify the design. Evaluation of the row operations is presented. GRA

**N89-18051#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**THE RECONFIGURABLE ARITHMETIC PROCESSOR**
Stuart Fiske and William J. Dally Jun. 1988 9 p
(Contracts N00014-80-C-0622; N00014-85-K-0214)
(AD-A200784; VLSI-MEMO-88-449) Avail: NTIS HC A02/MF A01 CSCL 12F

The Reconfigurable Arithmetic Processor (RAP) is an arithmetic processing node for a message-passing, MIMD concurrent computer. It incorporates on one chip several serial, 64 bit floating point arithmetic units connected by a switching network. By sequencing the switch through different patterns, the RAP chip calculates complete arithmetic formulas. By chaining together its arithmetic units the RAP reduces the amount of off chip data transfer; in the examples we have simulated off chip I/O can often be reduced to 30 or 40 percent of that required by a conventional arithmetic chip. Simulations predict a peak performance of 20M Flops with 800M bit/sec off chip bandwidth in a 2 micron CMOS process. GRA

**N89-18052#** Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
**A DATAFLOW/VON NEUMANN HYBRID ARCHITECTURE**
Robert A. Iannucci Jul. 1988 194 p
(Contracts N00014-83-K-0125; N00014-84-K-0099)
(AD-A200987; MIT/LCS/TR-418) Avail: NTIS HC A09/MF A01 CSCL 12F

This report examines the spectrum of architectures from von Neumann to dataflow by proposing a new architecture which is a hybrid of the two paradigms. The analysis attempts to discover those features of the dataflow architecture, lacking in a von Neumann machine, which are essential for tolerating latency and synchronization costs. These features are captured in the concept of a parallel machine language wherein the units of scheduling, called scheduling quanta, are bound at compile time rather than at instruction set design time. It is shown that the combination of dataflow-style explicit synchronization and von Neumann-style implicit synchronization results in an architectural synergism. Using an instruction set which is strictly less powerful than that of the MIT Tagged-Token Dataflow (TTDA), the hybrid architecture can exploit the same kinds of parallelism while executing fewer instructions, demonstrating the power of passing state implicitly between program-counter sequenced instructions. GRA

**N89-18382*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**IBM PC ENHANCES THE WORLD'S FUTURE**
Jozelle Cox *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 25-28 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 09B

**N89-18392*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE IBM PC AT NASA AMES**
James P. Peredo *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 113-118 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 09B

**N89-18400*#** National Aeronautics and Space Administration, Washington, DC.
**COMPUTER SCIENCES**
Paul H. Smith *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 49-81 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 09B

# 61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

**N89-18053** New South Wales Univ., Kensington (Australia).
**A COMPUTER BASED DECISION AID FOR FORECASTING MONTHLY TIME SERIES Ph.D. Thesis**
Robert Hugh Edmundson 1987 3 p
Avail: Issuing Activity

An interactive graphical decision aid for forecasting monthly time series of economic data, called GRAFFECT, was designed, implemented, and tested. The testing revealed judgmental extrapolations to be significantly more accurate than deseasonalized single exponential smoothing for a six month forecast horizon. The error rate was lower than any previously reported for the time series by a single forecasting method. The design of GRAFFECT was based, in part, on a study of the characteristics of time series and three methods of extrapolation. Following the accuracy studies, the subtasks in the extrapolation were examined. Seasonal pattern identification was examined in an ANOVA study conducted on nine time series, forecast using GRAFFECT and a hard copy plot of the series by ten postgraduate subjects. The use of GRAFFECT greatly reduced the difference in seasonal pattern from that determined using a ratio to centered moving average method. The data from the accuracy studies was examined to determine whether automatic processes for seasonal identification, trend identification, or extrapolation from the noise residual would improve the forecast. Author

**N89-18054#** Los Alamos National Lab., NM.
**A TRAINING PROGRAM FOR SCIENTIFIC SUPERCOMPUTING USERS**
Floyd Hanson, Thomas Moher, Nora Sabelli, and Ann Solem 1988 18 p Presented at the Supercomputing Conference, Orlando, FL, 14 Nov. 1988 Prepared in cooperation with Illinois Univ., Chicago
(Contract W-7405-eng-36)
(DE88-014417; LA-UR-88-2083; CONF-881112-5) Avail: NTIS HC A03/MF A01

This paper describes an eleven-week training program aimed principally at graduate and postdoctoral students in computationally-intensive fields. The program is designed to balance the specificity of computing center courses, the abstractness of computer science courses, and the personal contact of traditional apprentice approaches. It is based on the experience of computer scientists and computational scientists, and consists of seminars and clinics given by many visiting and local faculty. It covers a variety of supercomputing concepts, issues, and practices related to architecture, operating systems, software design, numerical considerations, code optimization, graphics, communications, and networks. Its research component encourages understanding of scientific computing and supercomputer hardware issues. Flexibility in thinking about computing needs is emphasized by the use of several different supercomputer architectures, such as the Cray X/MP48 at the National Center for Supercomputing Applications at University of Illinois at Urbana-Champaign, IBM 3090 600E/VF at the Cornell National Supercomputer Facility, and Alliant FX/8 at the Advanced Computing Research Facility at Argonne National Laboratory. DOE

**N89-18055** Brigham Young Univ., Provo, UT.
**AN INTEGRATED APPROACH TO COMPUTER-AIDED AIRCRAFT STRUCTURAL ANALYSIS Ph.D. Thesis**
Blaine W. Tew 1988 163 p
Avail: Univ. Microfilms Order No. DA8818888

Effective software and datafile management can enhance both engineering and manufacturing output. A method of integrating CAD, CAM, and finite element analysis software into a user friendly package which may be effectively used by both novice and expert users is given. The role and development of on-line documentation and effective users manuals are discussed. Many experts believe that a single dataset should be created and used for all CAEDM activities. The requirements and challenges of using a single dataset for CAD, CAM, and finite element analysis applications are reviewed. A scheme to effectively manage data generated by CAEDM software is also presented. Dissert. Abstr.

**N89-18056#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**USE OF STRUCTURAL MATCHING FOR REGISTRATION OF SATELLITE IMAGERY M.S. Thesis [USO DE CASAMENTO ESTRUTURAL PARA REGISTRO DE IMAGENS DE SATELITE]**
Leonardo SantAnnaBins Nov. 1988 97 p In PORTUGUESE; ENGLISH summary
(INPE-4734-TDL/345) Avail: NTIS HC A05/MF A01

Traditionally, registration of satellite images is based on correlation methods. A problem inherent to this kine of approach is the sensitivity to geometric and radiometric transformations. Here, a class of methods which is insensitive to a large class of geometric and radiometric transformations are studied: the structural matching, Instead of registering two intensity images, structural matching registers the intermediate symbolic descriptions of the images. On the other hand, a method of structural matching is proposed, which uses relaxation techniques. The method consists of the following steps. First, the images are segmented and the extracted objects are represented using shape and gray level descriptors. For each image, the spatial relation between the objects is computed and a description in the form of a directed graph is obtained. Second, an association graph is generated by establishing the possible correspondences between nosed and between arcs. The best match between structures is computed using relaxation techniques. Through a proper choice of attribute descriptors and spatial relations a matching can be found even in the presence of geometric and radiometric distortions. Some experiments are shown with the proposed method applied to satellite images and images and maps. Author

**N89-18057*#** Illinois Univ., Urbana-Champaign. Coordinated Science Lab.
**SPACE-BORNE COMPUTING FOR THE YEAR 2000 AND BEYOND**
Ravi K. Iyer and Prith Banerjee Dec. 1988 40 p
(Grant NAG1-613)
(NASA-CR-184779; NAS 1.26:184779; UILU-ENG-88-2265; CSG-95) Avail: NTIS HC A03/MF A01 CSCL 09B

The influence and utilization of computers in space science investigations greatly enhances the ability to address difficult and complicated questions about the Universe. Space Science is wholly dependent on computers because the data acquired from instruments on the spacecraft are not only complicated in form but also voluminous. Athough a great deal of attention has been paid to develop efficient and powerful computing systems on-ground, research in the area of spaceborne computing is far from satisfactory. On-board processing of data will be important in future planetary missions where telemetry rates constrain the total amount of data which can be returned and decisions may have to be made in real time. Little thought has been given to a dynamic man-machine interface with regard to scientific real-time interactive control of flight experiments. Careful thinking is therefore essential to define appropriate spaceborne computing requirements for the future. It is imperative that powerful multiprocessing systems for on-board processing be experimentally impleneted and evaluated in selected application missions. The presentation addresses key issues and attempts to define the requirements for such processing with some of NASA's future missions in perspective. The resulting architectural and performance issues and possible developments are also addressed. Author

**N89-18058*#** Illinois Univ., Urbana-Champaign. Coordinated Science Lab.
**TRAPEDS: PRODUCING TRACES FOR MULTICOMPUTERS VIA EXECUTION-DRIVEN SIMULATION**

Craig B. Stunkel and W. Kent Fuchs Dec. 1988 23 p
(Grant NAG1-613)
(NASA-CR-184777; NAS 1.26:184777; UILU-ENG-88-2261; CSG-94) Avail: NTIS HC A03/MF A01 CSCL 09B

Trace-driven simulation is an important aid in performance analysis of computer systems. Capturing address traces for these simulations is a difficult problem for single processors and particularly for multicomputers. Even when existing trace methods can be used on multicomputers, the amount of collected data typically grows with the number of processors, so I/O and trace storage costs increase. A new technique is presented which modifies the executable code to dynamically collect the address trace from the user code and analyzes this trace during the execution of the program. This method helps resolve the I/O and storage problems and facilitates parallel analysis of the address trace. If a trace stored on disk is desired, the generated trace information can also be written to files during execution, with a resultant drop in program execution speed. An initial implementation on the Intel iPSC/2 hypercube multicomputer is detailed, and sample simulation results are presented. The effect of this trace collection method on execution time is illustrated. Author

**N89-18059#** Sandia National Labs., Albuquerque, NM.
**DOEDEF SOFTWARE SYSTEM, VERSION 2.2: OPERATIONAL INSTRUCTIONS**
Lilita Meirans Nov. 1988 271 p
(Contract DE-AC04-76DP-00789)
(DE89-004455; SAND-88-2727) Avail: NTIS HC A12/MF A01

The DOEDEF (Department of Energy Data Exchange Format) Software System is a collection of software routines written to facilitate the manipulation of IGES (Initial Graphics Exchange Specification) data. Typically, the IGES data has been produced by the IGES processors for a Computer-Aided Design (CAD) system, and the data manipulations are user-defined flavoring operations. The DOEDEF Software System is used in conjunction with the RIM (Relational Information Management) DBMS from Boeing Computer Services (Version 7, UD18 or higher). The three major pieces of the software system are: Parser, reads an ASCII IGES file and converts it to the RIM database equivalent; Kernel, provides the user with IGES-oriented interface routines to the database; and Filewriter, writes the RIM database to an IGES file. DOE

**N89-18060#** International Atomic Energy Agency, Vienna (Austria).
**SOFTWARE FOR DATA REDUCTION Final Report, Jul. 1986 - Jul. 1987**
V. Teeyasoontranont (Chiang Mai Univ., Thailand ) Oct. 1987 36 p
(DE88-704108; IAEA-R-4478-F; CPHY-FNRF-8/87) Avail: NTIS (US Sales Only) HC A03/MF A01

The known mathematical technique of polynomial fitting to a set of experimental points was employed to develop a computer program for the P/OS operating system, for the DEC Professional series of personal computers. The program calculated the coefficients of a polynomial fit for a degree of up to ten, to a set of a maximum of a hundred measured points. It has a plotting routine to display the experimental values and the polynomial fit. A dependent variable can be calculated from the value of the input. The procedure was tested on a number of sets of experimental values, and found to give a satisfactory fit. DOE

**N89-18061#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Informatik.
**PROCEDURES FOR THE SELECTION AND EVALUATION OF CAD SYSTEMS Ph.D. Thesis [VERFAHREN ZUR AUSWAHL UND EVALUIERUNG VON CAD-SYSTEMEN]**
Luiz Ary Messina 1988 230 p In GERMAN
(ETN-89-93502) Avail: NTIS HC A11/MF A01

Procedures for the selection, evaluation, and configuring of CAD-systems were analyzed and implemented as prototypes. The use of CAD, and the use of graphics in computer aided decision making systems is discussed. Four procedures for the computer aided selection and evaluation of CAD systems are presented: support for efficiency calculations; data bank for CAD-system market alternatives; construction and management of systems architectures; and application value analysis. A graphical-interactive expert system for configuring of hardware and software was developed. The presented concepts and prototypes are a basis for further studies in depth. ESA

**N89-18062** National Physical Lab., Teddington (England). Div. of Information Technology and Computing.
**INSECURITIES IN THE Ada PROGRAMMING LANGUAGE Interim Report**
B. A. Wichmann Aug. 1988 48 p
(NPL-DITC-122/88; ISSN-0262-5369; ETN-89-93708) Copyright Avail: National Physics Laboratory, Teddington, Middlesex, TW11 0LW, United Kingdom

Three forms of insecurity in Ada which makes the use of the language problematic for high reliability applications: uncertainties in the language definition; uncertainties in the execution of programs which are incorrect but not rejected by compilers; and problems presented by bugs in implementations, are analyzed. There appears to be no essential barrier to producing high integrity Ada programs due to the language definition. An Ada implementor has quite a few options which can impact upon the integrity of the Ada program. For instance, the fact that parameters of composite types can be passed by copy or reference. In this respect, Ada is no different from FORTRAN in which a similar option on parameter passing exists. Implementation faults is a serious concern. Users should ask for an evaluation of the compiler by the Ada Evaluation Suite. ESA

**N89-18063#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**PDL: THE PROPER DESCRIPTION LANGUAGE. CONCEPTS AND BASIC LANGUAGE ELEMENTS**
Boudewijn R. Haverkort Mar. 1988 40 p
(MEMO-INF-88-04; ETN-89-93827) Avail: NTIS HC A03/MF A01

The basic elements of the model description language used in the performability modelling tool PROPER are reviewed. All the language constructs are discussed separately, together with examples of use. Special attention is paid to the description of failure/repair models. The syntax of PDL as well as implementation oriented issues are discussed. ESA

**N89-18064#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**SPECIFICATION OF THE TUMULT COMMUNICATION IN LOTOS**
Gerrit Niemeijer Jul. 1988 31 p
(MEMO-INF-88-29; ISBN-9-03-650170-9; ETN-89-93831) Avail: NTIS HC A03/MF A01

An exercise in the use of formal techniques in operating system design, a specification of a part of the TUMULT operating system, i.e., its communication primitives, in the formal specification language LOTOS is presented. The suitability of LOTOS for operating system design is reviewed. ESA

**N89-18065#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**DYNAMIC QUEUEING NETWORKS**
Boudewijn R. Haverkort and Ignas G. Niemegeers Sep. 1988 25 p Proposed for presentation at the ACM Sigmetrics and Performance 1989 Conference on Measurement and Modeling of Computer Systems, Berkeley, CA, 23-26 May 1989
(MEMO-INF-88-31; ISBN-9-03-650196-2; ETN-89-93832) Avail: NTIS HC A03/MF A01

A class of combined queueing network (QN) and generalized stochastic Petri net (GSPN) models to analyze the performance of systems with a dynamic structure is proposed. This includes the modeling of fault tolerant gracefully degradable computer systems. A GSPN is used to describe the dynamic behavior of the system under study. The possible markings are used as actual

parameters of a parameterized queueing network. Depending on the time-scales in the two model parts, either a direct overall solution method is proposed or, in case of big time-scale differences, a solution method based on behavioral decomposition is proposed. Due to the overall dynamic character of the models, not only steady state measures are addressed but also transient measures. The modeling approach stems from the generally assumed approach in performability modeling. The proposed dynamic queueing networks form a generalization of performability modeling. ESA

**N89-18066#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**PRETTY PRINT FACILITIES FOR REDUCE**
M. C. vanHeerwaarden and J. A. vanHulzen Aug. 1988 16 p
(MEMO-INF-88-36; ETN-89-93834) Avail: NTIS HC A03/MF A01

Simple REDUCE facilities for pretty-printing quotients, formal derivatives, and subscripted variables are presented. The package, an improved version of previously published possibilities, is completely written in RLisp and can be considered as an addition to the output repertoire of the Algebraic Mode. The print facilities for quotients are similar to those provided by MACSYNA and MAPLE. ESA

**N89-18067#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**FUNCTIONAL SPECIFICATION: A CASE STUDY**
S. Joosten Aug. 1988 40 p Sponsored by the Commission of the European Communities
(MEMO-INF-88-41; ISBN-9-03-650199-7; ETN-89-93839) Avail: NTIS HC A03/MF A01

It is shown how a functional software specification is made unambiguous and complete, without using special specification formalisms and without being programming language specific. A realistically sized example is worked out and an assessment of the specification process is given. The functional specification is made programming language independent by using conventional mathematics as specification language. The mathemetics used is restricted to high school maths and a little bit of undergraduate linear algebra. The mathematics can be understood by anyone involved in the design of software, technical managers and customers included. ESA

**N89-18068#** Oak Ridge National Lab., TN. Center for Intelligent Systems.
**KNOWLEDGE-BASED TECHNIQUES IN SOFTWARE ENGINEERING**
B. N. Jairam, A. Agarwal, and M. L. Emrich May 1988 37 p Presented at the CASE Studies Conference, Ann Arbor, MI, 23 May 1988
(Contract DE-AC05-84OR-21400)
(DE88-015318; CONF-8805143-1) Avail: NTIS HC A03/MF A01

Recent trends in software engineering research focus on the incorporation of AI techniques. The feasibility of an overlap between AI and software engineering is examined. The benefits of merging the two fields are highlighted. The long-term goal is to automate the software development process. Some projects being undertaken towards the attainment of this goal are presented as examples. Finally, research on the Oak Ridge Reservation aimed at developing a knowledge-based software project management aid is presented. DOE

**N89-18069#** Lawrence Livermore National Lab., CA.
**HOW CRACKERS CRACK PASSWORDS OR WHAT PASSWORDS TO AVOID**
Ana Maria DeAlvare 30 Sep. 1988 10 p
(Contract W-7405-eng-48)
(DE89-003715; UCID-21515) Avail: NTIS HC A03/MF A01

Computer security is a growing concern in research, development, marketing, and most other areas of everyday life. The first and foremost task in computer security is to prevent unauthorized access to systems. This report tells how crackers (computer wizards who use their talents for illegal and destructive purposes) obtain access to computer systems and gives specific advice on how to prevent them from doing it. DOE

**N89-18070#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.
**SOFTWARE ENGINEERING EDUCATION DIRECTORY Final Technical Report**
Albert L. Johnson Jan. 1988 92 p
(Contract F19628-85-C-0003)
(AD-A200630; CMU/SEI-88-TR-2; ESD-TR-88-003) Avail: NTIS HC A05/MF A01 CSCL 12E

The Software Engineering Institute (SEI) is a Federally funded research and development center, sponsored by the Department of Defense and operated by Carnegie Mellon University. The mission of the SEI is to serve the public interest by establishing the standard of excellence for the art and practice of software engineering and by accelerating the transition of software technology. This directory has been compiled to provide information that will help students and their advisors make appropriate educational choices. It contains a detailed listing of available software engineering course and software engineering degree programs. In the future editions of this directory, the publishers plan to provide indices and cross tabulations showing a profile of ongoing software engineering education efforts. GRA

**N89-18071#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.
**SUMMARY OF SEI (SOFTWARE ENGINEERING INSTITUTE) TECHNICAL OPERATIONS: 1987 Final Technical Report, Jan. - Dec. 1987**
Jan. 1988 78 p
(Contract F19628-85-C-0003)
(AD-A200631; CMU/SEI-88-TR-1; ESD-TR-88-002) Avail: NTIS HC A05/MF A01 CSCL 06A

The Software Engineering Institute (SEI) is a Federally funded research and development center sponsored by the Department of Defense (DOD). It was chartered by the Undersecretary of Defense for Research and Engineering on June 15, 1984. The SEI was established and is operated by Carnegie Mellon University (CMU) under contract F19628-85-C-0003, which was competitively awarded on December 26, 1984, by the Air Force Electronic System Division. The mission of the SEI is to provide the means to bring the ablest minds and the most effective technology to bear on the rapid improvement of the quality of operational software in mission-critical computer systems; to accelerate the reduction to practice of modern software engineering techniques and methods; to promulgate the use of modern techniques and methods throughout the mission-critical systems community; and to establish standards of excellence for the practice of software engineering. This report provides a summary of the programs and projects, staff, facilities, and service accomplishments of the Software Engineering Institute during 1987. GRA

**N89-18072#** California Univ., Los Angeles. Artificial Intelligence Lab.
**KNOWLEDGE REPRESENTATION FOR DESIGN CREATIVITY**
Jack Hodges, Margot Flowers, and Michael G. Dyer Jan. 1988 24 p
(Contract N00014-86-C-0615)
(AD-A200696; UCLA-AI-88-4) Avail: NTIS HC A03/MF A01 CSCL 12E

This paper briefly reports on the representational strategy used in EDISON, program currently being designed to: (1) invent novel mechanical devices through heuristic strategies of mutation, combination and analogy, and (2) to comprehend descriptions of invented device representations. The representational constructs required to support these tasks include: (1) intentional structures such as goals, plans and settings, which organize relationships between device use and context, (2) physical entities such as regions and materials, (3) functional relationships, such as connection and separation, which relate objects to their physical

behavior and (4) mechanical dependencies and inferences. Invented and comprehended device representations are indexed and generalized into a memory of design episodes. The organization of such a memory supports the use of cross-contextual reminding and analogy during problem solving. GRA

**N89-18073#** Rensselaer Polytechnic Inst., Troy, NY. Dept. of Computer Science.
**EPL (EQUATIONAL PROGRAMMING LANGUAGE) PARSING AND DIMENSION PROPAGATION**
Balaram Sinharoy Jun. 1988 172 p
(Contract N00014-86-K-0442)
(AD-A200722; RPI-TR-88-16) Avail: NTIS HC A08/MF A01 CSCL 12E

This report gives a detailed description of parsing and dimensionality propagation for the Equational Programming Language compiler. The Equational Programming Language, called EPL, is a very high-level declarative language designed to specify parallel and real-time computations. The EPL compiler translates equational specifications into procedural, high level language (currently C). The compiler itself is written in C for UNIX based systems. Automated tools YACC and LEX has been used for lexical analysis and parsing. Detailed description is given of the design and implementation of the algorithms for building different structures (such as symbol table, equation trees, etc.). These structures are used by subsequent post-parsing analysis and code-generation phases of the EPL compiler. The description of the algorithm for dimensionality propagation is also included. GRA

**N89-18074#** Rensselaer Polytechnic Inst., Troy, NY. Dept. of Computer Science.
**PROPAGATION OF DATA DEPENDENCY THROUGH DISTRIBUTED COOPERATING PROCESSES**
Kevin L. Spier Sep. 1988 64 p
(Contract N00014-86-K-0442)
(AD-A200723; RPI-TR-88-24) Avail: NTIS HC A04/MF A01 CSCL 12E

EPL is an equational programming language based on MODEL. In EPL, a computation to be performed by distributed cooperating processes is described as a set of specifications. The interconnections between processes are represented as a network graph. Processes' data dependencies are derived from these interconnections. If cycles exist in the network graph (which is the usual case) these dependencies would impose additional internal scheduling constraints, created from a transitive closure of all internal dependencies in the processes in the cycle. Therefore there is a need to derive these additional internal scheduling constraints from the internal data dependencies of all the processes and the network interconnections between them. This task requires careful analysis, which in previous versions of EPL had to be performed by the user. This thesis describes an algorithm, and its implementation, to automatically derive the additional intra-process scheduling constraints to generate the correct implementation for the target machine. This algorithm can also be used in automatic repartitioning of a process specification. GRA

**N89-18075#** Illinois Univ., Urbana-Champaign. Center for Supercomputing Research and Development.
**SOLVING LINEAR SYSTEMS ON MULTIPROCESSORS Final Report**
Ahmed H. Sameh Aug. 1988 18 p
(Grant AF-AFOSR-0211-85; AF Proj. 2304)
(AD-A200741; AFOSR-88-1117TR) Avail: NTIS HC A03/MF A01 CSCL 12E

The purpose of the research was to study robust iterative methods for solving spare (block tridiagonal) nonsymmetric linear systems in a parallel computing environment. A new method was developed which uses block-row symmetric successive overrelaxation (SSOR) with conjugate gradient (CG) acceleration. The method is robust, with convergence assured even for poorly conditioned systems, and the method is easily implemented in a parallel environment. The method transforms a nonsymmetric system with an arbitrary eigenvalue distribution into a symmetric one with eigenvalue restricted to the interval (0,1). Research included testing of the algorithms on an Alliant FX/8 multiprocessor where it was demonstrated that the method is very robust and performs better than standard existing methods. GRA

**N89-18076#** Environmental Research Lab., Athens, GA. Image Processing Systems Div.
**IDAPS (IMAGE DATA AUTOMATED PROCESSING SYSTEM) SYSTEM DESCRIPTION Technical Report, 1 Sep. 1987 - 29 Feb. 1988**
Paul Kortesoja 24 Jun. 1988 18 p
(Contract F08635-87-C-0074)
(AD-A200770; ERIM-202000-19-T) Avail: NTIS HC A03/MF A01 CSCL 12G

Described are the physical configuration and components used in the image processing system referred to as IDAPS (Image Data Automated Processing System). This system was developed by the Environmental Research Institute of Michigan (ERIM) for Eglin Air Force Base. The system is designed to perform manual (operator controlled) GADS (Graphic Attitude Determination System) processing and will serve as a baseline system designed for future enhancements to perform automatic GADS processing and other manual and automated image processing tasks. GADS image processing entails aligning a 2-D projection of a 3-D model of an object with a planar image of the actual object captured on film. In the manual GADS system the operator aligns the model to the object image by moving the model overlay on a monitor screen and visually aligning it with the object image on the screen. Once the model has been aligned to the image of the object, six parameters indicating the position and orientation of the object are obtained. This positional data is then stored in a file for subsequent processing. GRA

**N89-18077#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**OBJECT-ORIENTED CONCURRENT PROGRAMMING IN CST**
William J. Dally and Andrew A. Chien Jun. 1988 8 p
(Contracts N00014-80-C-0622; N00014-85-K-0124)
(AD-A200776; VLSI-MEMO-88-450) Avail: NTIS HC A02/MF A01 CSCL 12E

CST is a programming language based on Smalltalk-80 that supports concurrency using lock, asynchronous messages, and distributed objects. Distributed objects have their state distributed across many nodes of a machine, but are referred to by a single name. Distributed objects are capable of processing many messages simultaneously and can be used to efficiently connect together large collections of objects. They can be used to construct a number of useful abstractions for concurrency. This paper describes the CST language, gives examples of its use, and discusses an initial implementation. GRA

**N89-18078#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**AN INTELLIGENT PROCESS FLOW LANGUAGE EDITOR**
Rajeev Jayavant Sep. 1988 118 p
(Contract N00014-85-K-0213)
(AD-A200779; VLSI-MEMO-88-475) Avail: NTIS HC A06/MF A01 CSCL 12E

A process flow language allows a user to specify the process used to fabricate integrated circuits on a silicon wafer. By using a flow language, a designer can modify the process more easily and processing equipment can be reconfigured for use with different processes. While the benefits gained from using a process flow language have been discussed frequently, one major drawback of using a flow language has been overlooked: users must code their process flows in the flow language. This may not seem like a disadvantage, but it is rather difficult to convince people to do something they have never done before. Furthermore, the process must be in a language that faintly resembles Lisp, not a very appealing thought for users whose primary interest is in processing wafers, not programming computers. Thus there is a severe need for some tool to facilitate the coding of processes flows in the

process flow language. Various types of programming aids have been used in the past to facilitate software development: syntax checkers, semantic checkers, preprocessors, and intelligent editors. The process flow editor combines attributes from all of these. The primary difference between the process flow editor presents the flow to the user in a format that is very different from the format seen by applications accessing the flow. GRA

**N89-18079#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**A BAND RELAXATION ALGORITHM FOR RELIABLE AND PARALLELIZABLE CIRCUIT SIMULATION**
A. Lumsdaine, J. K. White, D. Webber, and A. L. Sangiovanni-Vincentelli Aug. 1988 14 p
(Contract N00014-87-K-0825)
(AD-A200783; VLSI-MEMO-88-466) Avail: NTIS HC A03/MF A01 CSCL 09A

A variable-band relaxation for solving large linear systems is developed as an alternative to Gauss-Jacobi relaxation. This algorithm seeks to improve the reliability of Gauss-Jacobi relaxation by extracting a variable-sized band from the matrix and solving that band directly. This leads to a relaxation algorithm with probably better convergence properties. Furthermore, this algorithm can be solved in log(n) time on n/2 processors. Test results are presented which compare the convergence properties of variable-band relaxation to Gauss-Jacobi relaxation. GRA

**N89-18080#** Rice Univ., Houston, TX.
**SOME PROBLEMS IN DATA BASED COMPUTER GRAPHICS AND SIMULATION Final Report, 1 Aug. 1985 - 31 Jul. 1988**
James R. Thompson 21 Oct. 1988 11 p
(Contract DAAG29-85-K-0212)
(AD-A200846; ARO-22406.2-MA) Avail: NTIS HC A03/MF A01 CSCL 12D

For three years topics in the general area of statistical computing have been investigated. We have developed, jointly with Dr. Malcolm Taylor of BRL the SIMDAT algorithm for using a set of projectile data to generate other data sets which could have happened. Also, we have developed a simulation based technique, SIMEST, to handle problems not tractable via the closed form maximum likelihood approach. We have obtained automated procedures for selecting bandwidths in the kernel density estimation. We have developed graphical techniques for demonstrating density estimates in dimensions as large as 6. We have done extensive work to build algorithms whose function is the creation of multicolored graphical displays of density estimates. We have done work in parameter estimation for time series problems using both frequency based and time based approaches. GRA

**N89-18081#** California Univ., Irvine.
**THE DESIGN OF AUTOMATIC PATTERN CLASSIFIERS Final Report, 1 Oct. 1984 - 30 Jun. 1988**
Jack Sklansky 6 Nov. 1988 20 p
(Contract DAAG29-84-K-0208)
(AD-A200920; ARO-21474.10-MA) Avail: NTIS HC A03/MF A01 CSCL 17E

Relational graphs and local training of piecewise linear decision surfaces are exploited to achieve improved procedures and insights in the design of automatic pattern classifiers. The orientations of the linear segments of these classifiers are used as guides in a branch-and-bound search for optimal subsets of features. Procedures are developed for determining near-optimal sequences of features for piecewise linear classifiers. Developed are new procedures for selecting small subsets of features from large initial sets for use in automatic pattern classifiers. An interactive relational graph design technique for the design of piecewise linear two-class classifiers is extended to the design of multiple-class classifiers. This research led to solutions of several fundamental problems associated with the use of automatic classifiers of detected candidate military targets appearing in aerial and terrestrial images. These problems fall in three areas; data analysis, classifier design, and classifier architectures. The author developed a highly effective means of discovering clusters in multiple-dimensional data, using the CAMPA (Clustering and Mapping for Pattern Analysis) interactive software in conjunction with modern computer graphics. GRA

**N89-18082#** Naval Research Lab., Washington, DC. Human Computer Interaction Lab.
**ADAPTIVE HUMAN-COMPUTER INTERFACES**
A. F. Norcio and J. Stanley 30 Sep. 1988 19 p
(AD-A200930; NRL-9148) Avail: NTIS HC A03/MF A01 CSCL 23B

Interface software that can adapt to the current user and the current context is a long-term research goal of the Adaptive Interface project at the Naval Research Laboratory's Human-Computer Interaction Laboratory. This report presents a survey of recent research in adaptive interface computer software as well as a discussion of factors that require consideration in designing this software. An adaptive interface needs to include a knowledge base that encompasses four domains. These four domains are knowledge of the current user, knowledge of the interaction scheme, knowledge of the problem task, and knowledge of the underlying system. This report reviews and discusses these knowledge bases along with the positive and negative aspects of adaptive interfaces. GRA

**N89-18083#** Duke Univ., Durham, NC. Graduate School of Business Administration.
**COMMUTATIVITY-BASED LOCKING FOR NESTED TRANSACTIONS**
Alan Fekete, Nancy Lynch, Michael Merritt, and Bill Weihl Aug. 1988 76 p
(Contracts N00014-83-K-0125; N00014-85-K-0168; NSF CCR-86-11442; NSF CCR-87-16884)
(AD-A200980; MIT/LCS/TM-370) Avail: NTIS HC A05/MF A01 CSCL 12E

A new model is introduced for reasoning about atomic transactions. This model allows careful statement of the correctness conditions to be satisfied by transaction-processing algorithms, as well as clear and concise description of such algorithms. It also serves as a framework for rigorous correctness proofs. A new algorithm is introduced for general commutativity-based locking in nested transaction systems. This algorithms. It also serves as a framework for rigorous correctness proofs. A new algorithm is introduced for general are based on Serializability Theorem and a new dynamic atomicity condition for data objects. GRA

**N89-18084#** Duke Univ., Durham, NC. Graduate School of Business Administration.
**HYBRID CONCURRENCY CONTROL FOR ABSTRACT DATA TYPES**
Maurice P. Herlihy and William E. Weihl Aug. 1988 30 p
(Contracts N00014-83-K-0125; F33615-84-K-1520; NSF DCR-85-10014; NSF CCR-87-16884; ARPA Order 4976)
(AD-A200981; MIT/LCS/TM-368) Avail: NTIS HC A03/MF A01 CSCL 12G

Atomic transactions are a widely accepted mechanism for coping with failures and concurrency in database systems, both distributed and centralized. Many algorithms have been proposed for concurrency control and recovery. Recent work has focused on typed objects, such as queues, directories, or counters, that provide a richer set of operations. Several algorithms have been proposed to enhance concurrency and recovery by exploiting data objects' type-specific properties. Most of these algorithms are locking schemes in which conflicts are governed by some notion of commutativity: lock modes for commuting operations do not conflict. This paper presents a new locking algorithm that permits more concurrency than existing commutativity-based protocols. In addition, the protocol permits operations to be both partial and non-deterministic, and it permits the lock mode for an operation to be determined by its results as well as its name and arguments. The protocol exploits type-specific properties of objects; necessary and sufficient constraints on lock conflicts are defined directly

from a data type specification. We give a complete formal description of the protocol, encompassing both concurrency control and recovery, and prove that the protocol satisfies hybrid atomicity, a local atomicity property that combines aspects of static and dynamic atomic protocols. We also show that the protocol is optimal in the sense that no hybrid atomic locking scheme can permit more concurrency. GRA

**N89-18085#** Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
**ASSISTING DESIGN GIVEN MULTIPLE PERFORMANCE CRITERIA**
Dennis C. Fogg Aug. 1988 70 p
(Contract N00014-83-K-0125)
(AD-A200982; MIT/LCS/TM-363) Avail: NTIS HC A04/MF A01 CSCL 12G

A design system that accepts multiple performance criteria faces the problem of trading off one criterion for another. Understanding the user's preference about such tradeoffs is essential to producing the most desirable design. An argument is made against specifying preferences over all possibilities before the design process begins. The proposed solution reduces its dependence on the specification's accuracy by encouraging interaction between the user and the system. The system produces quick, high quality information about realizable designs and performance tradeoffs between them. The user interactively evaluates, directs, and terminates the design exploration. Techniques called decoupled design, alteration strategies, and sample search are key elements in the implementation. Decoupled design generates a large number of designs efficiently (an alternative technique using linear programming is also presented). Alteration strategies are abstract descriptions of design modifications that assist in directing the design process and creating novel structures. Sample search is a framework to control search using domain specific heuristics. The design system operates in the domain of non-regular, application specific, signal processing architectures. The design process occurs in two phases: First the architectural structure with uninstantiated operators is created then each operator's implementation is selected. GRA

**N89-18086#** Duke Univ., Durham, NC. Graduate School of Business Administration.
**SEQUENTIAL IMPLEMENTATION OF LENIENT PROGRAMMING LANGUAGES Ph.D. Thesis**
Kenneth R. Traub Oct. 1988 203 p
(Contract N00014-84-K-0099)
(AD-A200984; MIT/LCS/TR-417) Avail: NTIS HC A10/MF A01 CSCL 12E

In non-strict functional languages, a data structure may be read before all its components are written, and a function may return a value before finishing all its computation or even before all its arguments have been evaluated. Such flexibility gives expressive power to the programmer, but makes life difficult for the compiler because it may not be possible to totally order instructions at compile time; the correct order can vary dramatically with the input data. Presently, compiler for non-strict languages rely on lazy evaluation, in which a subexpression is not evaluated until known (at run time) to contribute to the final answer. By scheduling each subexpression separately, lazy evaluation automatically deals with the varying orderings required by non-strictness, but at the same time incurs a great deal of overhead. Recent research has employed strictness analysis and/or annotations to make more scheduling decisions at compile time, and thereby reduce the overhead, but because these techniques seek to retain laziness, they are limited in effectiveness. The author discusses his strategy in the context of both sequential implementations and parallel implementations where the object code is partially sequentialized. We also show how lazy code can be generated from our framework. GRA

**N89-18087#** Army Construction Engineering Research Lab., Champaign, IL.
**PROJECT DOCUMENTATION (PROJDOC) USER'S MANUAL Final Report**
Michael T. McCulley, Michael R. Schulz, Don Kermath, and Janice L. Koszczuk Oct. 1988 77 p
(Contracts DACA88-86-Q-0674; DACA88-86-D-0006)
(AD-A201014; CERL-ADP-P-89/04) Avail: NTIS HC A05/MF A01 CSCL 12E

The production of project documentation is a difficult, protracted exercise. Any revisions to a project require complete recalculation and reproduction of the project documentation. Project Documentation (ProjDoc) is a computer program that will produce draft Military Construction Army Reserve (MCAR) project documentation in minutes. ProjDoc requires no special computer training. It runs on IBM compatible computers with at least 640k memory, PC DOS 3.1 or higher, 1 floppy disk drive, 1.4 megabytes of free hard disk for the program and approximately 36 kilobytes of free hard disk for each facility in the data base, and a printer with 12 characters per inch. GRA

**N89-18088#** Naval Postgraduate School, Monterey, CA.
**A DATABASE APPROACH TO COMPUTER INTEGRATED MANUFACTURING Ph.D. Thesis**
Dana E. Madison Jun. 1988 320 p
(AD-A201030) Avail: NTIS HC A14/MF A01 CSCL 13H

This work presents a new approach to the integration of manufacturing activities. The manufacturing environment has capitalized on the use of automation to evolve to a highly specialized state characterized by heterogeneous systems providing computer support to the various activities. Conventional approaches to integration assume that these activities must continue to exist in their current relationships. We use a database approach to the integration problem which removes the traditional boundaries between activities. We develop a data model which captures more of the semantics of the manufacturing environment than existing models and allows us to take a data-oriented perspective of the activities it encompasses. We also show how the use of the data-oriented approach provides for integration of these activities and reduces the complexity of the manufacturing environment. GRA

**N89-18089#** Surveillance Research Lab., Salisbury (Australia).
**NOTES ON RUNNING THE GENERALISED SYNTHETIC APERTURE RADAR SOFTWARE PACKAGE**
D. M. McDonald May 1988 19 p
(AD-A201071; SRL-0013-TM; DODA-AR-005-385) Avail: NTIS HC A03/MF A01 CSCL 17I

These notes refer to the Generalized Synthetic Aperture Radar (GSAR) Software Package developed by MacDonald Dettwiler and Associates. The version to which these notes refer is adapted to a VAX computer with a Floating Point Systems (FPS) array processor of the AP120B family. These notes are intended to complement the Operators Reference Manual particularly in areas which led to confusion on installation. GRA

**N89-18090#** North Carolina Univ., Chapel Hill. Dept. of Computer Science.
**GRASPING REALITY THROUGH ILLUSION: INTERACTIVE GRAPHICS SERVING SCIENCE**
Frederick P. Brooks, Jr. Mar. 1988 15 p
(Contract N00014-86-K-0680)
(AD-A201086; TR88-007) Avail: NTIS HC A03/MF A01 CSCL 23B

Discussed are three related subjects: virtual-worlds research-the construction of real-time three dimensional illusions by computer graphics; some observations about interfaces to virtual worlds; and the coming application of virtual-worlds techniques to the enhancement of scientific computing. We need to design generalized interfaces for visualizing, exploring, and steering scientific computations. These interfaces must be direct-manipulation, not command-string; interactive, not batch; 3-D, not 2-D; multi-sensory, not just visual. Needed are generalized

research results for 3-D interactive interfaces. More is known than gets reported, because of a reluctance to share unproven results. The author proposes a shells-of-certainty model for such knowledge. GRA

**N89-18091#** North Carolina Univ., Chapel Hill. Dept. of Computer Science.
**AN OPTIMALLY PORTABLE SIMD (SINGLE-INSTRUCTION MULTIPLE-DATA) PROGRAMMING LANGUAGE**
Russ Tuck Oct. 1988 14 p
(Contracts N00014-86-K-0680; W-31-109-eng-38; PHS-RR-02170; DARPA Order 6090)
(AD-A201089; TR88-048) Avail: NTIS HC A03/MF A01 CSCL 12E

Existing programming languages for SIMD (Single-Instruction Multiple-Data) parallel computers make implicit architectural assumptions. These limit each language to architectures satisfying its assumptions. This paper presents a theoretical foundation for developing much more portable languages for SIMD computers. It also describes working progress on the design and implementation of such a language. An optimally portable programming language for a set of architectures is one which allows each program to specify the subset of those architectures on which is must be able to run, and which then allows the program to exploit exactly those architectural features available on all of the target architectures. The features available on an architecture can implement with a constant-bounded number of operations. This definition ensures reasonable execution efficiency, and identifies architectural differences which are relevant to algorithm selection. An optimally portable programming language for SIMD computers, call Porta-SIMD (porta-simm'd), is being developed to demonstrate these ideas. Based on C++, ot currently runs on the Connection Machine and Pixels 4. GRA

**N89-18092#** North Carolina Univ., Chapel Hill. Dept. of Computer Science.
**PIXEL-PLANES 4: A SUMMARY**
John Eyles, Henry Fuchs, Trey Greer, and John Poulton 1987 25 p
(Contract DAAG29-83-K-0148)
(AD-A201090) Avail: NTIS HC A03/MF A01 CSCL 12F

We describe the current state of the Pixel-planes research project, whose goal is to develop powerful raster graphics systems for the next generation of workstations. The first full-scale prototype has been in regular use in our department's computer graphics laboratory since its first demonstration at SIGGRAPH '86, more than a year ago. We describe the final hardware configuration of the prototype system, filling in some of the engineering details heretofore unpublished. Next we outline the programming environment for the machine and summarize the major algorithms that have been developed. Finally we discuss our progress towards a new generation of the Pixel-planes architecture, Pixel-planes 5. GRA

**N89-18093#** Pittsburgh Univ., PA. Learning Research and Development Center.
**EXPLANATORY COHERENCE AND BELIEF REVISION IN NAIVE PHYSICS**
Michael Ranney and Paul Thagard Jul. 1988 25 p
(Contract N00014-84-K-0223)
(AD-A201093; UPITT/LRDC/ONR/APS-17) Avail: NTIS HC A03/MF A01 CSCL 12I

Students of reasoning have long tried to understand how people revise systems of beliefs. We maintain that people often change their beliefs in ways driven by considerations of explanatory coherence. This report describes a computational model of how experimental subjects revise their naive beliefs about physical motion. First, instances are presented in which subjects changed their beliefs while learning elementary physics. Each of these cases involved an individual's attempt to explain a surprising observation. Next, we show how their belief revisions can be modeled using ECHO, a connectionist computer program that uses constraint satisfaction techniques to implement a theory of explanatory coherence. The resulting simulations even captured temporal characteristics of the observed changes in beliefs. Finally, the model's representational sensitivity and procedural robustness are discussed and one can show how ECHO can be used to generate empirical predictions about subjects' current beliefs. GRA

**N89-18094#** Naval Postgraduate School, Monterey, CA.
**HOW GOOD ARE GLOBAL NEWTON METHODS, PART 2 Technical Report, Oct. 1987 - Aug. 1988**
Allen A. Goldstein 1 Sep. 1988 39 p
(AD-A201099; NPS53-88-010-Pt-2) Avail: NTIS HC A03/MF A01 CSCL 12A

Newton's method applied to certain problems with a discontinuous derivative operator is shown to be effective. A global Newton method in this setting is exhibited and its computational complexity is estimated. As an application a method is proposed to solve problems of linear inequalities (linear programming, phase 1). Using an example of the Klee-Minty type due to Blair, it was found that the simplex method (used in super-lindo) required over 2,000 iterations, while the method above required an average of 8 iterations (Newton steps) over 15 random starting values. GRA

**N89-18395*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE APPLICATIONS OF COMPUTERS IN BIOLOGICAL RESEARCH**
Jennifer Wei *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 131-133 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 09B

# 62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

**N89-18095#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**ON IDENTIFYING RESOURCES IN MULTIPROCESSOR SYSTEMS**
E. G. Zondag Mar. 1988 22 p
(MEMO-INF-88-12; ETN-89-93828) Avail: NTIS HC A03/MF A01

Issues in identifying resources and their attributes in multiprocessor systems: identification structures, human and machine-oriented identifications, and problems are treated. Suggestions for uniformly identifying all kinds of resources at the human level, based on a hierarchical identifying structure are made. Uniform identifying contributes to reduced system complexity, both for users and for programmers. Two important identifying service primitives, assign and alias, may contribute to this uniformity. The first associates a human-readable identification with a resource in order to enhance its reachability, which is useful, e.g., in system testing and debugging. The second associates a shorthand designation for complex identification specifications or elaborate identification handling. An experiment for the TUMULT multiprocessor system is discussed in which uniform identifying is employed for the set of tasks, processes, communication links, and processors in the system, primarily for software monitoring purposes. Extensions of this limited identifying service that would enhance its possibilities are discussed. ESA

**N89-18096#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**A THEORY FOR THE DERIVATION OF TESTS**
Ed Brinksma Apr. 1988 21 p Sponsored by the Commission of the European Communities ESPRIT ST-410 Project and Ministry of Education, Netherlands
(MEMO-INF-88-19; ETN-89-93829) Avail: NTIS HC A03/MF A01

A theory for the derivation of tests from a specification for testing conformance of implementations is outlined. This theory is generally applicable to formal description methods that allow a semantic interpretation of specifications in terms of labelled transition systems with internal transitions. Examples of the application of this theory to LOTOS specifications are given. ESA

**N89-18097#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**HIGH LEVEL SYNCHRONIZATION SERVICES OF OSI: COMMITMENT, CONCURRENCY AND RECOVERY**
Ibrahim Ajubi and Marten vanSinderen Sep. 1988 19 p
(MEMO-INF-88-35; ISBN-9-03-650190-3; ETN-89-93833) Avail: NTIS HC A03/MF A01

The Commitment, Concurrency and Recovery (CCR) application-oriented protocol for Open Systems Interconnection is discussed. It offers service elements in support of successful coordination and completion of distributed application activities in the presence of network failures and system crashes. The user requirements for such a protocol are outlined. It is concluded that these requirements are met by the OSI CCR service. An ad hoc protocol that provides the CCR service and uses the Session service is formally specified by application of the formal description technique LOTOS. Based on this exercise, conclusions with respect to the current definition of the OSI CCR protocol are drawn. ESA

**N89-18098#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**THE CO-OP METHOD: A METHOD FOR COMPOSITIONAL DERIVATION OF CANONICAL TESTERS M.S. Thesis**
Clazien D. Wezeman Sep. 1988 91 p Sponsored in part by the Department of Trade and Industry, London, United Kingdom
(MEMO-INF-88-38; ETN-89-93836) Avail: NTIS HC A05/MF A01

A method for the construction of conformance testers T(S) from process algebraic specifications S is presented. It is shown that this CO-OP method leads to the construction of optimized canonical testers. It is applied to basic LOTOS behavior expressions and is shown to be compositional; i.e., a tester T(B1 asterisk B2) can be constructed from the attributes of the testers T(B1) and T(B2), where asterisk is any basic LOTOS operator. ESA

**N89-18099#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**INTERCONNECTION OF CONTINUOUS BITSTREAM AND STREAM ORIENTED NETWORKS**
Aiko Pras and Jeroen Schot Sep. 1988 27 p
(MEMO-INF-88-39; ISBN-9-03-650192-X; ETN-89-93837) Avail: NTIS HC A03/MF A01

It is argued that continuous bitstream and stream oriented protocol functions should be used in the design of integrated services digital networks. Voice and video applications require a connection-oriented global network service. For voice applications, the transfer delay should not exceed 80 msec. The transfer delay does not need to be a fixed value. Data should be kept in sequence by the global network provider. A voice connection requires a fixed throughput of 64 kbit/sec, a video connection requires a fixed throughout of 2 Mbit/sec. Subnetworks to be interconnected may provide a connection-oriented, or a connectionless service: FDDI II and ISDN (basic access and primary rate) both provide a connection-oriented service; FDDI I and BWN are examples of subnetworks that provide a connectionless service. In all cases, the transfer delay of the subnetworks should have a guaranteed upper bound. Existing internet protocols, designed to support voice, video and data applications, are not known. Existing internet protocols, designed for data applications, are not suited for voice and video applications for reasons of efficiency. ESA

**N89-18100#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**THE VAX/VMS ANALYSIS AND MEASUREMENT PACKET (VAMP): A CASE STUDY**
J. Hoogendoorn, R. C. Marcelis, A. P. deGrientDreux, Jan vanderWal, and R. J. Wijbrands Mar. 1988 17 p
(MEMO-COSOR-88-09; ETN-89-93866) Avail: NTIS HC A03/MF A01

The VAX/VMS Analysis and Measurement Packet (VAMP) was tested on proposed changes to a configuration of three VAX's sharing background memory. It is concluded that even for a relatively small system change, it is very hard to give a good performance prediction. ESA

**N89-18101#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**OPTIMAL SIMULATIONS BY BUTTERFLY NETWORKS**
Sandeep N. Bhatt, Fan R. Chung, Jia-Wei Hong, F. T. Leighton, and Arnold L. Rosenberg Mar. 1988 37 p
(Contracts N00014-80-C-0622; N00014-87-K-0825; NSF DCI-87-96236; NSF MIP-86-01885)
(AD-A200780; VLSI-MEMO-88-469) Avail: NTIS HC A03/MF A01 CSCL 12G

The power of Butterfly-type networks relative to other proposed multicomputer interconnection networks is studied, by considering how efficiently the Butterfly can simulate the other networks. Simulation is represented formally via graph embeddings, so the topic here becomes: How efficiently can one embed the graph underlying a given network in the graph underlying the Butterfly network. The efficiency of an embedding of a graph G in a graph H is measured in terms of: the dilation, or, the maximum amount that any edge of G is stretched by the embedding; the expansion, or, the ratio of the number of vertices of H to the number vertices of G. These results, which extend to Butterfly-like graphs such as the Cube-Connected Cycles and Benes networks, supply the first examples of graphs that can be embedded more efficiently in the Hypercube than in the Butterfly. GRA

**N89-18102#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**EVALUATING THE PERFORMANCE OF SOFTWARE CACHE COHERENCE**
Susan Owicki and Anant Agarwal Oct. 1988 22 p
(Contract N00014-87-K-0825)
(AD-A200788; VLSI-MEMO-88-478) Avail: NTIS HC A03/MF A01 CSCL 12E

In a shared-memory multiprocessor with private caches, cached copies of a data item must be kept consistent. This is called cache coherence. Both hardware and software coherence schemes have been proposed. Software techniques are attractive because they avoid hardware complexity and can be used with any processor-memory interconnection. This paper presents an analytical model of the performance of two software coherence schemes and, for comparison, snoopy-cache hardware. The model is validated against address traces from a bus-based multiprocessor. The behavior of the coherence schemes under various workloads is compared, and their sensitivity to variations in workload parameters is assessed. The analysis shows that the performance of software schemes is critically determined by certain parameters of the workload: the proportion of data accesses, the fraction of shared references, and the number of times a shared block is accessed before it is purged from the cache. Snoopy caches are more resilient to variations in these parameters. Thus when evaluating a software scheme as a design alternative, it is essential to consider the characteristics of the expected workload. The performance of the two software schemes with a multistage interconnection network is also evaluated, and it is determined that both scale well. GRA

**N89-18103#** Massachusetts Inst. of Tech., Cambridge. Microsystems Research Center.
**FINE-GRAIN MESSAGE-PASSING CONCURRENT COMPUTERS**
William J. Dally Aug. 1988 13 p Sponsored in part by NSF

and General Electric Corp.
(Contracts N00014-80-C-0622; N00014-87-K-0825; N00014-85-K-0124)
(AD-A200789; VLSI-MEMO-88-454) Avail: NTIS HC A03/MF A01 CSCL 12F

Fine-grain concurrent computers, by operating at a fine grain, increase the amount of concurrency that can be efficiently exploited in a given problem. Programming is simplified because programs may be partitioned into natural units of methods and objects and these objects are addressed uniformly whether they are local or remote. The construction of these machines poses challenging problems in reducing overhead, increasing communication bandwidth, and developing resource management techniques. This paper describes this class of machines, the challenges posed by their construction, and recent progress toward meeting these challenges. GRA

**N89-18104#** Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
**GRAPH-THEORETIC TECHNIQUES FOR PARALLEL, DISTRIBUTED, AND SEQUENTIAL COMPUTATION Ph.D. Thesis**
Serge A. Plotkin Sep. 1988 176 p
(Contracts N00014-87-K-0825; N00014-86-K-0593)
(AD-A200989; MIT/LCS/TR-430) Avail: NTIS HC A09/MF A01 CSCL 12E

Parallel computation presents problems which are either nonexistent or trivial in the context of sequential computation. Thus, design of efficient algorithms for parallel and distributed computation requires development of new tools and techniques. This thesis considers a number of fundamental problems that arise in the context of parallel and distributed computation and describes several graph-theoretic techniques to address these problems. It also presents several new insights into the structure of various combinatorial optimization problems. GRA

**N89-18105#** North Carolina Univ., Chapel Hill. Dept. of Computer Science.
**A PARALLEL ARCHITECTURE FOR k-D TREES**
Geoffrey A. Frank and Donald F. Stanat May 1988 24 p
(Contract N00014-86-K-0680)
(AD-A201087; TR88-026) Avail: NTIS HC A03/MF A01 CSCL 12F

The authors describe a special purpose computer architecture for the parallel processing of queries, including associative searches, in a dynamic file. The architecture is a highly-parallel network of small processors of two types connected in a full binary tree network. Records are stored in the leaves of the tree; each leaf processor is responsible for records occurring within a rectangular solid part of the space. Queries and record updates are fed into the root of the tree. Internal nodes selectively direct each query and update to leaves so that each leaf sees only the information geometrically close to the records for which it is responsible. File updates cause a reorganization of the tree, which is accomplished in a manner that can accommodate either incremental or massive changes. The architecture can be viewed as a hardware implementation of Bentley's k-d trees. The design is extensible and well-suited to implementation in VLSI. GRA

**N89-18106#** Massachusetts Univ., Amherst. Dept. of Computer and Information Science.
**LOCAL/GLOBAL CONTROL INTEGRATION Final Report, Jul. 1981 - Jul. 1987**
John A. Stankovic, Don Towsley, C. G. Rommel, Spiridon Pulidas, and Ravi Mirchandaney Aug. 1988 276 p
(Contract F30602-81-C-0206)
(AD-A201117; RADC-TR-88-138) Avail: NTIS HC A13/MF A01 CSCL 12F

Decentralized control is investigated with respect to the scheduling and reallocation functions of distributed computer systems. We have made significant progress on developing and analyzing several scheduling and reallocation algorithms. In particular, we have investigated distributed scheduling algorithms where tasks are independent of each other and the subnet imposes a non-negligible delay on task transfers. We have also studied distributed scheduling algorithms that specifically consider collections of related tasks which we classify as distributed scheduling groups and clusters. Since many distributed systems have nodes which are multiprocessors, we have also addressed multiprocessor scheduling. We have studied scheduling in such an environment by analytically analyzing the performance of fork-join jobs and by developing a multi-class, multiprocessor scheduling algorithm. During this contract period, we have also developed a decentralized reallocation algorithm, analyzed it via simulation, and in the analysis, emphasized different forms and costs of cooperation. We show that decentralized reallocation is significantly better than centralized reallocation. Finally, we also developed decentralized estimation techniques to be used in conjunction with distributed scheduling algorithms. GRA

**N89-18107#** North Carolina Univ., Chapel Hill. Dept. of Computer Science.
**COMBINING Z-BUFFER ENGINES FOR HIGHER-SPEED RENDERING**
Steven Molnar 1988 10 p
(Contract N00014-86-K-0680; DARPA Order 6090)
(AD-A201137) Avail: NTIS HC A02/MF A01 CSCL 12F

Described is a hardware architecture for combining the outputs of a number of z-buffer rendering engines to achieve higher performance than is possible with a single renderer. It allows a combination of renderers to achieve the same price/performance ratio as the individual renderers that compose it, and can be extended to create systems with arbitrarily high performance. The described architecture is based on a fusion of scan-line rendering and the conventional z-buffer algorithm. The frame buffers of several z-buffer engines are modified to scan out z-values as well as color values. Multiplexing devices combine the z/color streams from each pair of frame-buffers. These z/color streams are then combined by further multiplexers, creating a binary tree that funnels the z/color information from the many conventional frame buffers into a single z/color stream. The color stream is then used to drive a standard display device. The proposed architecture allows rendering rates of millions and even tens of millions of polygons per second. The basic architecture can be extended with additional hardware to perform antialiasing and texture-mapping. GRA

**N89-18108#** National Inst. of Standards and Technology, Gaithersburg, MD. Center for Computing and Applied Mathematics.
**MEASURING PERFORMANCE OF PARALLEL COMPUTERS Annual Progress Report**
Francis Sullivan 1988 14 p
(Contract DE-AI05-87ER-25046)
(DE89-005956; DOE/ER-25046/1) Avail: NTIS HC A03/MF A01

The major questions needing to be answered are: how can codes be improved; what kind of codes should be run on what kind of machine. Our point of view is that data motion is the principal determining factor in the performance of algorithms on parallel machines. Our approach to performance measurement has been to first develop a taxonomy for algorithmic paradigms based on how the data moves during the calculation, rather than on what the specific computational steps are. Thus, from this viewpoint, Ising spin simulations occur in two different places in the taxonomy as applications, depending on which algorithm is to be used. Benchmark codes typical of applications in each class of the taxonomy have been developed and implemented on different parallel computers in order to explore the relations between the taxonomy and the machine event level of a layered framework or spectrum. The upper level is the applications which dictate the required computational load. The lowest level is machine events, memory and communication links, having capabilities that should satisfy the upper level requirements. DOE

**N89-18393*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**LOCAL AREA NETWORKING: AMES CENTERWIDE NETWORK**
Edwin Price *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 119-121 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 09B

# 63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

**N89-18109#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**ON LOCAL RIGHT-INVERTIBILITY OF NONLINEAR CONTROL SYSTEMS**
H. Nijmeijer and W. Respondek (Polish Academy of Sciences, Warsaw.) Mar. 1988 27 p
(MEMO-697; B8809589; ISSN-0921-1969; ETN-89-93818) Avail: NTIS HC A03/MF A01

For nonlinear control systems, the question of generating a given trajectory in the output space by suitably chosen inputs is considered. Two aspects are studied, namely the initial state is fixed, or there is freedom in varying the initial state. The former corresponds to the ability of generating higher time-derivatives of the output signal while the latter permits adjustment of lower time-derivatives. Based on a solution of the dynamic input-output decoupling problem, necessary and sufficient conditions for right-invertibility are given. They are expressed as a list of equivalent conditions which mimics, as far as possible, an analogous list for linear systems. Geometric aspects are also discussed. ESA

**N89-18110#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**SUFFICIENT CONDITIONS FOR BOUNDED INPUT BOUNDED OUTPUT (BIBO) ROBUST STABILIZATION: GIVEN BY THE GAP METRIC**
S. Q. Zhu, M. L. J. Hautus, and C. Praagman Oct. 1987 19 p
(MEMO-COSOR-87-26; ETN-89-93852) Avail: NTIS HC A03/MF A01

A relation between coprime fractions and the gap metric is presented. Using this result sufficient conditions for bounded input bounded output robust stabilization for a very wide class of systems are provided. These conditions allow the plant and compensator to be disturbed simultaneously. ESA

**N89-18111#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**THE REGULAR FREE-ENDPOINT LINEAR QUADRATIC PROBLEM WITH INDEFINITE COST**
Harry L. Trentelman Oct. 1987 25 p
(MEMO-COSOR-87-28; ETN-89-93853) Avail: NTIS HC A03/MF A01

An open problem in the context of linear quadratic optimal control, the free-endpoint regular linear quadratic problem with indefinite cost functional is studied. It is shown that the optimal cost for this problem is given by a particular solution of the algebraic Riccati equation. This solution is characterized in terms of the geometry on the lattice of all real symmetric solutions of the algebraic Riccati equation as developed by Willems and Coppel. A necessary and sufficient condition for the existence of optimal controls is established. This condition is stated in terms of a subspace inclusion involving the extremal solutions of the algebraic Riccati equation. It is shown that the optimal controls are generated by a feedback control law. Results are compared with classical results on the linear quadratic regulator problem. ESA

**N89-18112#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**MONOTONICITY OF THE THROUGHPUT IN SINGLE SERVER PRODUCTION AND ASSEMBLY NETWORKS WITH RESPECT TO THE BUFFER SIZES**
Ivo Adan and Jan vanderWal Dec. 1987 16 p
(MEMO-COSOR-87-35; ETN-89-93858) Avail: NTIS HC A03/MF A01

The single-server tree-shaped production and assembly network with arbitrary arrival streams, Markovian routing, and nonzero, independent, and generally distributed service times is considered. It is shown that the throughput is monotone in the sizes of the local buffers, using sample path comparison. Most of the assumptions can be relaxed, such as independent service times and Markovian routing. ESA

**N89-18113#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**A RECURSIVE AGGREGATION-DISAGGREGATION METHOD TO APPROXIMATE LARGE-SCALE CLOSED QUEUEING NETWORKS WITH MULTIPLE JOB TYPES**
Jan vanDoremalen (Philips International B.V., Eindhoven, Netherlands ) and Jaap Wessels Apr. 1988 21 p
(MEMO-COSOR-88-08; ETN-89-93865) Avail: NTIS HC A03/MF A01

A recursive aggregation-disaggregation method is introduced to bypass the computational problems involved in evaluating the standard multidimensional recursive schemes associated with exact mean value analysis in separable queuing networks with multiple job types. As a side result the influence of Pollaczek-Khintchine type approximations for the mean response times at first-in first-out single server queues with nonexponential service demand distributions is studied. The power of the method is shown with a closed central server model involving multiple central processors, disk units, and job types. ESA

**N89-18114#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**LOT-SIZING AND FLOW PRODUCTION IN AN MRP-ENVIRONMENT**
L. Frijters, T. deKok (Philips International B.V., Eindhoven, Netherlands ), and Jaap Wessels May 1988 10 p
(MEMO-COSOR-88-14; ETN-89-93870) Avail: NTIS HC A02/MF A01

Methods to analyze a production process for professional equipment with advanced electronic and mechanical features are developed. The starting point of the analysis is to find ways for production control and production organization which maintain and strengthen the advantages of the MRP-system, but also mend the disadvantages. The main advantages which could be further improved are the lead times for customer orders and the inventories of buy-parts and subassemblies. The disadvantages which should be mended are high costs of order releases, materials handling, and data processing. ESA

**N89-18115#** California Univ., Berkeley. Electronics Research Lab.
**ADAPTIVE AND NONLINEAR CONTROL METHODOLOGIES**
**Final Report, 15 Mar. 1985 - 14 Mar. 1988**
Shankar S. Sastry 17 Aug. 1988 24 p
(Contract DAAG29-85-K-0072)
(AD-A200694; ARO-22205.8-MA) Avail: NTIS HC A03/MF A01 CSCL 09A

The contents of this report on adaptive and nonlinear control methodologies are as follows: (1) Perspectives in Adaptive Systems: Frequency Domain Analysis and Use of Prior Information, (2) Frequency Domain Techniques for the Analysis and Synthesis of Adaptive Systems, (3) Identification of Continuous Time Systems in the Presence of Unmodeled Dynamics, (4) Adaptive Control; Stability, Parameter Convergence and Robustness. GRA

**N89-18116#** Stanford Univ., CA. Dept. of Computer Science.
**MAKING INTELLIGENT SYSTEMS ADAPTIVE: REVISION**

Barbara Hayes-Roth Oct. 1988 28 p
(Contract N00039-83-C-0136)
(AD-A200913; SU-STAN-CS-88-1226-REV; KSL-88-64-REV)
Avail: NTIS HC A03/MF A01 CSCL 12F

Contemporary intelligent systems are isolated problem-solvers. They accept classes of problems, reason about them, perhaps request additional information, and eventually produce solutions. By contrast, human beings and other intelligent animals continuously adapt to the demands and opportunities presented by a dynamic environment. Adaptation plays a critical role in everyday behaviors, such as conducting a conversation, as well as in sophisticated professional behaviors, such as monitoring critically ill medical patients. To make intelligent systems similarly adaptive, we must augment their reasoning capabilities with capabilities for perception and action. Equally important, we must endow them with an attentional mechanism to allocate their limited computational resources among competing perceptions, actions, and cognitions, in real time. In this paper, we discuss functional objectives for adaptive intelligent systems, an architecture designed to achieve those objectives, and continuing study of these objectives and architecture in the context of particular tasks. GRA

**N89-18117#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**MACHINE INTELLIGENCE APPLIED TO RADAR OBJECT MODELING**
Ann Marie Aull and Robert A. Gabel 12 Oct. 1988 33 p
(AD-A200938; TR-818) Avail: NTIS HC A03/MF A01 CSCL 17I

In this report, we discuss a machine intelligence approach to modeling simple space objects from radar range-Doppler images. The data is multidimensional in nature with additive noise, distortion, and missing points. The relevant features to be extracted from the radar data include the position of all scattering centers in body coordinates, identification of the scattering center type (sphere, corner, edge, etc.), and motion parameters for the object. Our goal is to produce a representation of the imaged 3-dimensional object that is appropriate for recognizing the object as an example of something we have seen before and cataloged, recognizing the object as an uncataloged object, or determining discrepancies between the recognized object and our expectations of its appearance. We have built a recognition system with three major conceptual modules. The first of these is a set of signal processing primitives that are directed at the data to select subsets of data, extract features, and compare extracted features with the data to produce confidence measures. The second major module is the semantic model building and matching scheme. This component takes the data-derived features and produces a semantic model which is then matched against a catalog of stored semantic models for object identification. GRA

**N89-18118#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**BOUNDARIES AND TOPOLOGICAL ALGORITHMS**
Margaret M. Fleck Aug. 1988 450 p
(Contract N00014-85-K-0124)
(AD-A201040; AI-M-TR-1065) Avail: NTIS HC A19/MF A01 CSCL 08B

This thesis develops a model for the topological structure of situations. In this model, the topological structure of space is altered by the presence or absence of boundaries, such as those at the edge of objects. This allows the intuitive meaning of topological concepts such as region connectivity, function continuity, and preservation of topological structure to be modelled using the standard mathematical definitions. The thesis shows that these concepts are important in a wide range of artificial intelligence problems, including low-level vision, high-level vision, natural language semantics, and high-level reasoning. A formal framework for manipulating space and boundaries is developed, called cellular topology. Combinatorial methods of representing the topological structure of digitized space are developed and used to develop formal models of the changes in space induced by boundaries. The cellular structure imposed on space restricts the form of representations in ways that are useful for artificial intelligence applications. The cell structure, together with descriptions of the support and error neighborhoods of functions, provides a convenient model for the scale or resolution of representations used in applications. Two algorithms were implemented for this thesis: an edge finder and a stereo matcher. GRA

# 64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

**N89-18119** New South Wales Univ., Kensington (Australia). School of Education.
**LOCUS OF DIFFICULTY IN MULTI-STAGE MATHEMATICS PROBLEMS Ph.D. Thesis**
Paul L. Ayres 1987 2 p
Avail: Issuing Activity

Previous studies have suggested that the use of a means-ends problem solving strategy imposes a heavy cognitive load which interferes with learning. Some of the contributing factors are discussed. A computational model was constructed that suggested that cognitive load is at a maximum when subgoals are manipulated and calculated. This allowed the prediction that on two move problems, most errors should occur during the calculation of the subgoal rather than the goal. This event was referred to as stage effect. Using three move problems, most errors were located at the subgoal immediately preceding the goal. This suggested that a means-end strategy was more likely to be used at this location than at more distant locations. Protocol analysis supported this suggestion. Finally, if no-goal problems enhance learning by eliminating the use of means-end analysis as has been found, then the stage effect found using conventional problems should be eliminated using equivalent no-goal problems. Conclusions are drawn and discussed. Author

**N89-18120#** International Centre for Theoretical Physics, Trieste (Italy).
**DIVISION ALGEBRAS WITH INTEGRAL ELEMENTS**
Mehmet Koca and Nazife Ozdes Jun. 1988 40 p
(DE88-704231; IC-88/131) Avail: NTIS (US Sales Only) HC A03/MF A01

Pairing two elements of a given division algebra furnished with a multiplication rule leads to an algebra of higher dimension restricted by 8. This fact is used to obtain the roots of SO(4) and SP(2) from the roots + or - 1 of SU(2) and the weights + or - 1/2 of its spinor representation. The root lattice of SO(8) described by 24 integral quaternions are obtained by pairing two sets of roots of SP(2). The root system of F(sub 4) is constructed in terms of 24 integral and 24 half-integral quaternions. The root lattice of E(sub 8) expressed as 240 integral octonions are obtained by pairing two sets of roots of F(sub 4). Twenty-four integral quaternions of SO(8) forming a discrete subgroup of SU(2) is shown to be the automorphism group of the root lattices of SO(8), F(sub 4) and E(sub 8). The roots of maximal subgroups SO(16), E(sub 7)XSU(2), E(sub 6)XSU(3), SU(9) and SU(5)XSU(5) of E(sub 8) are identified with a simple method. Subsets of the discrete subgroup of SU(2) leaving maximal subgroups of E(sub 8) are obtained. Constructions of E(sub 8) root lattice with integral octonions in 7 distinct ways are made. Magic square of integral lattices of Goddard, Nahm, Olive, Ruegg and Schwimmer are derived. Possible physical applications are suggested. DOE

**N89-18121#** International Centre for Theoretical Physics, Trieste (Italy).
**GENERALIZED MONOTONE OPERATORS IN BANACH SPACES**
Sudarsan Nanda (Utkal Univ., Bhubaneswar, India ) Jul. 1988 6 p
(DE88-704237; IC-88/139) Avail: NTIS (US Sales Only) HC A02/MF A01

The concept of F-monotonicity was first introduced by Kato and this generalizes the notion of monotonicity introduced by Minty. The purpose of this paper is to define various types of F-monotonicities and discuss the relationships among them.
DOE

**N89-18122#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Physik.
**REGULARIZATION OF DEGENERACY SINGULARITIES BY FACTORIZATION OF THE TIME EVOLUTION OPERATOR IN EXPONENTIAL REPRESENTATION Ph.D. Thesis [REGULARISIERUNG VON ENTARTUNGSSINGULARITAETEN DURCH FAKTORISIERUNG DES ZEITENTWICKLUNGSOPERATORS IN EXPONENTIALDARSTELLUNG]**
Thomas Mannel 1987 150 p In GERMAN
(ETN-89-93497) Avail: NTIS HC A07/MF A01

A factorization of the time evolution operator was made with a view to degeneracy singularities. The starting point was the exponential representation of the time evolution operator, providing a unique approximation. The matrix elements were calculated using the method of the quasi-normal order with which the exponential representation can be renormalized. Examples of applications in the field of quantum electrodynamics are given. The advantage of the proposed method is that the IR and UV ranges can be treated simultaneously. For the calculation of cross sections in such fields as QCD and electro-weak theory, the method provides the possibility to calculate systematically radiation corrections. The method can also treat more theoretical questions such as the analytical structure of Green's functions. ESA

**N89-18123** National Physical Lab., Teddington (England). Div. of Information Technology and Computing.
**A COMPARISON OF FOUR FINITE AND INFINITE ELEMENT TECHNIQUES**
Simon A. Hannaby Aug. 1988 22 p
(NPL-DITC-123/88; ISSN-0262-5369; ETN-89-93709) Copyright Avail: National Physics Laboratory, Teddington, Middlesex, TW11 0LW, United Kindgom

Four techniques for solving infinite problems: truncated finite elements, two mapped infinite elements, and one decay function infinite element, are compared in solving four ordinary differential equations. Results show a distinct benefit in using infinite element methods over truncated finite elements. For problems whose solution behaves like e sup (-kx) or like the reciprocal of a logarithm, the best solutions are obtained using the Bettess infinite element. When the solution behaves like the reciprocal of a polynomial, the best results are obtained using the Zienkiewicz infinite element or the simpler zero-pole element. Unless something is known about the solution in advance, the simple zero-pole mapped element is preferable to the Bettess and Zienkiewicz elements in view of the work involved in optimizing their parameters. ESA

**N89-18124#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**NOTE ON THE RELATION BETWEEN STOKES MULTIPLIERS AND FORMAL SOLUTIONS OF ANALYTIC DIFFERENTIAL EQUATIONS**
G. K. Immink Feb. 1988 21 p
(MEMO-690; B8809582; ISSN-0921-1969; ETN-89-93814) Avail: NTIS HC A03/MF A01

A result of Balser, Jurkat, and Lutz (1979) concerning the relation between the Stokes multipliers of a homogeneous linear differential equation with an irregular singularity and the asymptotic behavior of the coefficients of the formal solutions of the equation is generalized. ESA

**N89-18125#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**SYMMETRIES FOR THE SUPER MODIFIED KORTEWEG-DEVRIES (KdV) EQUATION**
P. H. M. Kersten Feb. 1988 14 p
(MEMO-691; B8809583; ISSN-0921-1969; ETN-89-93815) Avail: NTIS HC A03/MF A01

Higher order or generalized symmetries for the super modified Korteweg-deVries equation are constructed. By the introduction of graded potentials nonlocal symmetries are obtained, one of them leading to the recursion operator for symmetries in a straightforward way. ESA

**N89-18126#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**INFINITE DIMENSIONAL PARAMETER IDENTIFICATION FOR STOCHASTIC PARABOLIC SYSTEMS**
Shinichi Aihara and Arunabha Bagchi (Kyushu Inst. of Tech., Kitakyushu, Japan ) Feb. 1988 14 p
(MEMO-692; B8809584; ISSN-0921-1969; ETN-89-93816) Avail: NTIS HC A03/MF A01

The infinite dimensional parameter estimation for stochastic heat diffusion equations is considered using the method of sieves. The consistency property for the long run data is also studied. ESA

**N89-18127#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**COVERING NODES BY K NODE-DISJOINT TREES WITH ADDITIONAL CONSTRAINTS**
S. M. Baas and J. OrestesCerdeira Feb. 1988 13 p
(MEMO-693; B8809585; ISSN-0921-1969; ETN-89-93817) Avail: NTIS HC A03/MF A01

Given a complete undirected weighted graph G with k+n nodes including a subset K of k (1 less than or = k less than or = n) the problem of covering, at minimum cost, the nodes of G by k node-disjoint trees such that each tree includes no more than one node from K is considered. A 0(n sq = k sq n) time algorithm that may be regarded as a combination of a minimum spanning tree algorithm with a type of augmenting path procedure for matchings in bipartite graphs is used. The inclusion of additional equality constraints on the degrees of the nodes belonging to an arbitrary subset K' of K is considered. It is shown that the same algorithm also solves this restricted version of the problem in 0(n sq + (D+k-/K'/)sq n) time, where D is the sum of the required degrees for the nodes in set K'. As a special case, the algorithm turns out to be a 0(n sq + D sq n) time algorithm for the minimum spanning tree having degree equal to D on a specified node. ESA

**N89-18128#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**A RELAXATION METHOD FOR THE SET PACKING PROBLEM USING POLYHEDRAL CHARACTERISTICS**
S. M. Baas, M. C. Bonvanie, and A. J. Verschoor Mar. 1988 17 p
(MEMO-699; B8811729; ISSN-0921-1969; ETN-89-93820) Avail: NTIS HC A03/MF A01

A relaxation method for solving set packing problems is considered. A class of standard facets is generated from the underlying intersection graph. In order to determine these standard facets a heuristic labeling method was developed. Experiments show that many medium-sized problems can be efficiently solved by an LP-based procedure, including sequential facet generation. ESA

**N89-18129#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**TRANSFORMATIONS OF NONLINEAR SYSTEMS UNDER EXTERNAL EQUIVALENCE**
A. J. vanderSchaft Mar. 1988 26 p
(MEMO-700; B8811730; ISSN-0921-1969; ETN-89-93821) Avail: NTIS HC A03/MF A01

Smooth nonlinear systems described by higher-order equations in the external variables (inputs and outputs) and latent variables (such as (partial) states and auxiliary variables), shortly external differential systems, are considered. It is shown how locally one can eliminate the latent variables, and how the external differential

system can be transformed into a row-reduced form. Further equivalence transformations are applied for obtaining state space representations and for investigating the conditions for input-output realizability. ESA

**N89-18130#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**PATH GRAPHS**
H. J. Broersma and C. Hoede Mar. 1988 30 p
(MEMO-701; B8811731; ISSN-0921-1969; ETN-89-93822) Avail: NTIS HC A03/MF A01

The concept of line graph is generalized to that of path graph. The path graph Pk (G) of a graph G is obtained by representing the paths Pk is G by vertices and joining two vertices whenever the corresponding paths Pk in g form a path P(k + 1) or a cycle G (k). P3-graphs are characterized and investigated on isomorphism and traversability. Trees and unicyclic graphs with Hamiltonian P3-graphs are characterized. ESA

**N89-18131#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**A GENERALIZATION OF A RESULT OF HAGGKVIST AND NICOGHOSSIAN (1981)**
Douglas Bauer, H. J. Broersma, H. J. Veldman, and Li Rao (Harbin Inst. of Tech., China ) Mar. 1988 11 p
(MEMO-703; B8811733; ISSN-0921-1969; ETN-89-93824) Avail: NTIS HC A03/MF A01

Using a variation of the Bondy-Chvatal closure theorem, the following result is proved: If g is a 2-connected graph with n vertices and connectivity K such that d(x)+d(y)+d(z) is greater than or = n + K, for any triple of independent vertices x, y, z, then G is Hamiltonian. ESA

**N89-18132#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**LOCAL AND GLOBAL FLUCTUATIONS OF A THREE PARTICLE SYSTEM**
S. A. vanGils, E. vanGroesen, and T. P. Valkering Mar. 1988 10 p
(MEMO-704; B8811734; ISSN-0921-1969; ETN-89-93825) Avail: NTIS HC A02/MF A01

Systems of differential equations with symmetry are discussed, and it is recalled that at a Hopf bifurcation point, where a symmetric steady state loses its stability, more than one branch of periodic states may be produced. Each of these branches can be detected by restricting the state space suitably, and applying standard Hopf bifurcation results within the restricted state space. It is shown how the same ideas can be applied to obtain global branches by variational methods. Again, symmetry considerations lead to the choice of suitable function spaces. The level branches can be continued globally by minimizing suitable functionals. Details for a three particle system are given. ESA

**N89-18133#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**A DIOPHANTINE EQUATION OF ANTONIADIS**
B. M. M. deWeger 1948 18 p
(MEMO-705; B8811735; ISSN-0921-1969; ETN-89-93826) Avail: NTIS HC A03/MF A01

It is proved that the diophantine equation 31.x sq + 1 = y cubed has exactly the solutions (x,y) = (0,1), (2,5), (-2,5), by solving a related Thue-equation, using the theory of linear forms in logarithms and computational methods from diophantine approximation theory. ESA

**N89-18134#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**AXIOMATIC FUNCTION THEORY (EXTENDED ABSTRACT)**
Jan Kuper Aug. 1988 10 p
(MEMO-INF-88-37; ETN-89-93835) Avail: NTIS HC A02/MF A01

An axiomatic theory about functions, where functions are taken in the extensional sense, i.e., they are completely determined by all the individual correspondences between arguments and results is described. However, functions are not identified with sets of these correspondences, but are considered as objects in their own right. So the theory gives a possibility to reason formally about functions in a more direct way than by means of sets of ordered pairs. The resulting theory provides a formal framework for concepts like currying: ZF-Set Theory can be embedded in it; and it contains models for typed and untyped variants of the lambda calculus. The concept of function (in the extensional sense) can be axiomatized in much the same way as the concept of set, and the resulting theory is rather like ZF-set theory. ESA

**N89-18135#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**A NEW METHOD FOR COMPUTING A COLUMN REDUCED POLYNOMIAL MATRIX**
Th. G. J. Beelen, G. J. vandenHurk (Philips Gloeilampenfabrieken N. V., Eindhoven, Netherlands ), and C. Praagman Oct. 1987 13 p
(MEMO-COSOR-87-25; ETN-89-93851) Avail: NTIS HC A03/MF A01

An algorithm for computing a column reduced form of a given full column rank polynomial matrix is presented. The method is based on reformulating the problem of constructing a minimal basis for the right nullspace of a polynomial matrix closely related to the original one. The latter problem can easily be solved in a numerically reliable way. Two examples illustrating the method are included. ESA

**N89-18136#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**A NECESSARY AND SUFFICIENT CONDITION FOR SOLVABILITY OF THE LINEAR-QUADRATIC CONTROL PROBLEM WITHOUT STABILITY**
A. H. W. Geerts Oct. 1987 14 p Sponsored by the Netherlands Organization for the Advancement of Pure Scientific Research
(MEMO-COSOR-87-31; ETN-89-93856) Avail: NTIS HC A03/MF A01

A necessary and sufficient condition for the existence of a minimizing control for the regular non-negative definite linear-quadratic control problem without stability is given. This condition is given in terms of the original system coefficients and is also necessary and sufficient for the existence of a positive semidefinite solution of the algebraic Riccati equation. ESA

**N89-18137#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**INPUTS, OUTPUTS AND STATES IN THE REPRESENTATION OF TIME SERIES**
C. Praagman Oct. 1987 11 p
(MEMO-COSOR-87-32; ETN-89-93857) Avail: NTIS HC A03/MF A01

Results on numerically reliable algorithms for polynomial matrices are used to obtain various representations for families of time series, specified a priori by AR-equations. All algorithms are numerically reliable, but some are very time consuming. ESA

**N89-18138#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**ON ESTIMATING THE PARAMETERS OF A DYNAMIC MODEL FROM NOISY INPUT AND OUTPUT MEASUREMENTS**
J. M. tenVregelaar Jan. 1988 20 p
(MEMO-COSOR-88-02; ETN-89-93860) Avail: NTIS HC A03/MF A01

An algorithm to compute least squares estimates for the parameters of a dynamic model from noisy measurements of inputs and outputs is provided. Estimating the unknown parameters of a dynamic model with errors in all variables by means of the least squares method gives an object function which contains an inverse matrix. A Q - R decomposition to evaluate object function and gradient is proposed. These are used in an iterative procedure in order to obtain estimates. Though in general the object function

can not be written as a sum of independent random variables weak consistency under mild conditions on input, system and noise can be proved. ESA

**N89-18139#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**A NOTE ON FAMILIES OF LINEAR-QUADRATIC PROBLEMS: CONTINUITY PROPERTIES**
A. H. W. Geerts Feb. 1988 12 p Sponsored by the Netherlands Organization for Scientific Research
(MEMO-COSOR-88-05; ETN-89-93862) Avail: NTIS HC A03/MF A01

One-parameter (epsilon) families of linear-quadratic problems with stability are investigated. It is shown that the set of invariant zeros of the epsilon-problem is contained in the set of invariant zeros of the boundary problem (the problem with epsilon = 0) if the boundary system is left invertible. This result is obtained only by applying assumptions on the continuity and the monotonicity of the weighting matrices. ESA

**N89-18140#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**A CONTINUITY PROPERTY OF A PARAMETRIC PROJECTION AND AN ITERATIVE PROCESS FOR SOLVING LINEAR VARIATIONAL INEQUALITIES**
Siquan Zhu Feb. 1988 18 p
(MEMO-COSOR-88-06; ETN-89-93863) Avail: NTIS HC A03/MF A01

A method for solving linear variational inequalities by reducing a linear variational inequality to a series of simple sublinear variational inequalities which can be easily solved is presented. The continuity of the operator used is proved, and this result is used to prove the convergence theorem. ESA

**N89-18141#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**RAPID VARIATION WITH REMAINDER AND RATES OF CONVERGENCE**
E. Beirland (Katholieke Universiteit te Leuven, Belgium ) and E. Willekens Feb. 1988 17 p
(MEMO-COSOR-88-07; ETN-89-93864) Avail: NTIS HC A03/MF A01

The remainder term of a class of rapidly varying functions is considered. Probabilistic applications to limit laws of extreme value theory and to the estimation of the index parameter of a regularly varying tail are considered. ESA

**N89-18142#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**ABELIAN AND TAUBERIAN THEOREMS FOR THE LAPLACE TRANSFORM OF FUNCTIONS IN SEVERAL VARIABLES**
E. Omey and E. Willekens Apr. 1988 20 p
(MEMO-COSOR-88-10; ETN-89-93867) Avail: NTIS HC A03/MF A01

Using two kinds of multivariate regular variation, Abel-Tauber theorems for the Laplace transform of functions in several variables are studied. Power series results of Alpar are generalized. Results are applied multivariate renewal theory. ESA

**N89-18143#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**EXACT PAIRED COMPARISON DESIGNS FOR QUADRATIC MODELS**
E. E. M. vanBerkum May 1988 18 p
(MEMO-COSOR-88-12; ETN-89-93868) Avail: NTIS HC A03/MF A01

The construction of designs in paired comparison experiments is considered. The procedures that are used in paired comparisons to estimate the parameters yield a covariance matrix that depends on the unknown parameters. The assumption of no treatment differences is made to construct designs. By use of D-optimal discrete designs, exact designs are constructed with a high efficiency and a relatively small number of pairs, for a quadratic model for 2, 3, 4, and 5 dimensions and hypercube as experimental region. ESA

**N89-18144#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**PARAMETER ESTIMATION FROM NOISY OBSERVATIONS OF INPUTS AND OUTPUTS**
J. M. tenVregelaar May 1988 27 p
(MEMO-COSOR-88-13; ETN-89-93869) Avail: NTIS HC A03/MF A01

An algorithm to compute least squares estimates for the parameters of a dynamic model from noisy measurements of inputs and outputs is given. The corresponding estimators are proved to be strongly consistent and asymptotically normal under assumptions. ESA

**N89-18145#** International Centre for Theoretical Physics, Trieste (Italy).
**LIOUVILLE'S EQUATION. PART 3: SYMMETRIES OF THE LINEARIZED EQUATION**
Y. Sobouti and J. Samimi Jul. 1988 31 p
(DE88-704715; IC-88/160) Avail: NTIS (US Sales Only) HC A03/MF A01

Let the linearized Liouville-Poisson equation be i delta f/delta t = Af, f = f(q,p), p = momentum coordinate. A on f's is not a Hermitian operator. However, an eigenvalue equation Af(sub w) = wf(sub w), with real w's and non orthogonal eigenfunctions can be set up. For spherically symmetric potentials A and A(sup 2) have 0(3) symmetry. There exists an angular momentum operator, J(sub i), which commutes with A. This classifies the eigenfunctions into classes specified by a pair of eigennumbers (j,m) belonging to (J(sup 2),J(sub z)). This in turn enables one to separate the dependence of the eigenfunctions on the direction angles of (q,p) and reduce the six-dimensional phase space problem into a two-dimensional one in terms of the magnitudes (q,p). DOE

**N89-18146#** International Centre for Theoretical Physics, Trieste (Italy).
**TRANSFER MATRICES FOR MULTILAYER STRUCTURES**
R. Baquero Aug. 1988 7 p
(DE88-704730; IC-88/185) Avail: NTIS (US Sales Only) HC A02/MF A01

We consider four of the transfer matrices defined to deal with multilayer structures. We deduce algorithms to calculate them numerically, in a simple and neat way. We illustrate their application to semi-infinite systems using SGFM formulae. These algorithms are of fast convergence and allow a calculation of bulk-, surface- and inner-layers band structure in good agreement with much more sophisticated calculations. Supermatrices, interfaces and multilayer structures can be calculated in this way with a small computational effort. DOE

**N89-18147*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**AUTOMATIC MATHEMATICAL MODELING FOR REAL TIME SIMULATION PROGRAM (AI APPLICATION)**
Caroline Wang and Steve Purinton Feb. 1989 66 p
(NASA-TM-100356; NAS 1.15:100356) Avail: NTIS HC A04/MF A01 CSCL 12A

A methodology is described for automatic mathematical modeling and generating simulation models. The major objective was to create a user friendly environment for engineers to design, maintain, and verify their models; to automatically convert the mathematical models into conventional code for computation; and finally, to document the model automatically. Author

**N89-18148#** North Carolina Univ., Chapel Hill. Dept. of Statistics.
**ADMISSIBLE TRANSLATES OF STABLE PROCESSES: A SURVEY AND SOME NEW MODELS**
Stamatis Cambanis Jul. 1988 13 p

(Contract F49620-85-C-0144; AF Proj. 2304)
(AD-A200636; TR-235; AFOSR-88-1109TR) Avail: NTIS HC A03/MF A01 CSCL 12C

This document surveys some recent results on the admissible translates of stable processes and we contrast them with the analogs for Gaussian processes. Whereas Gaussian moving averages and Fourier transforms of independent increments processes have rich classes of admissible translates, their stable counterparts frequently have all translates singular. By removing the requirement of independence of the increments, we introduce stable processes that are generalized moving averages and harmonizable which can have rich classes of admissible translates. These are generally nonstationary processes but we also show a class of stationary generalized moving averages. GRA

**N89-18149#** California Univ., Santa Barbara. Center for Computational Sciences and Engineering.
**STABILITY ANALYSIS OF FINITE DIFFERENCE APPROXIMATIONS TO HYPERBOLIC SYSTEMS, AND PROBLEMS IN APPLIED AND COMPUTATIONAL MATRIX THEORY Final Report, 1 May 1983 - 30 Apr. 1988**
Moshe Goldberg and Marvin Marcus 8 Jul. 1988 130 p
(Grant AF-AFOSR-0150-83; AF Proj. 2304)
(AD-A200755; AFOSR-88-1184TR) Avail: NTIS HC A07/MF A01 CSCL 12A

Research completed under Grant AFOSR-83-0150 by Moshe Goldberg consists 2 convenient stability criteria for difference approximation to hyperbolic initial-boundary value problem, and 2 multiplicativity and stability of matrix and operator norms. GRA

**N89-18150#** Naval Research Lab., Washington, DC.
**FREQUENCY-HOPPED SPREAD-SPECTRUM SYSTEMS HAVE A LARGER MULTIPLE-ACCESS CAPABILITY: THE EFFECT OF INTERFERING SIGNALS WITH UNEQUAL POWER LEVELS**
Evaggelos A. Geraniotis 8 Nov. 1988 48 p Prepared in cooperation with Locus, Inc., Alexandria, VA; and Maryland Univ., College Park
(AD-A200949; NRL-MR-6363) Avail: NTIS HC A03/MF A01 CSCL 12I

A new method is presented for the evaluation of the probability of error of uncoded frequency-hopped spread-spectrum multiple-access (FH/SSMA) communications. For systems with binary FSK modulation, the method provides an accurate approximation and a tight upper bound to the bit error probability; for systems with M -ary FSK modulation, it provides tight upper bounds to the symbol error probability. This method relies on the integration of the product of the characteristic function of the envelope of the branch of the BFSK demodulator, which carries the desired signal, and of the derivative of the characteristic function of the envelope of the other branch; it can achieve any desirable accuracy and the computational effort required for its evaluation grows linearly with the number of interfering users. In the M -ary case, tight upper bounds based on the union bound and the results of the binary case are derived. GRA

**N89-18151#** California Univ., Santa Barbara. Center for Computational Sciences and Engineering.
**STABILITY ANALYSIS OF FINITE DIFFERENCE SCHEMES FOR HYPERBOLIC SYSTEMS AND PROBLEMS IN APPLIED AND COMPUTATIONAL LINEAR ALGEBRA Progress Report, 1 May - 29 Jul. 1988**
Moshe Goldberg and Marvin Marcus 20 Jul. 1988 4 p
(Grant AF-AFOSR-0175-88; AF Proj. 2304)
(AD-A201083; AFOSR-88-1190TR) Avail: NTIS HC A02/MF A01 CSCL 12B

During the period May 1- July 29, 1988, progress was made under Grant AFOSR-88-0175 in the following two areas: (1) E. Tadmor and Goldberg managed to unify the two main stability criteria in a previous paper: Convenient stability criteria for difference approximations of hyperbolic initial-boundary value problems. This is the content of a forthcoming paper: Simple stability criteria for difference approximations of hyperbolic initial boundary value problems, which is expected to appear in the Proceedings of the Second International Conference on Hyperbolic Problems; and (2) Arens of UCLA and Goldberg have made significant progress in characterizing multiplicativity factors and other multiplicativity properties of seminorms on operator algebras. This is done mainly by studying the kernels of the seminorms. It is anticipated that a preliminary manuscript will be ready by the end of the summer. GRA

**N89-18152#** North Carolina Univ., Chapel Hill. Dept. of Computer Science.
**NEAR REAL-TIME CSG (CONSTRUCTIVE SOLID GEOMETRY) RENDERING USING TREE NORMALIZATION AND GEOMETRIC PRUNING**
Jack Goldfeather, Steven Molnar, Greg Turk, and Henry Fuchs 1988 24 p
(Contract N00014-86-K-0680)
(AD-A201085; TR88-006) Avail: NTIS HC A03/MF A01 CSCL 12E

Described is a set of algorithms for efficiently rendering a CSG-defined objective directly into a frame buffer without converting first to a boundary representation. The method requires only that the frame buffer contain sufficient memory to hold two color values, two z values, and three one-bit flags. The algorithm first converts the CSG tree to a normalized form that is analogous to the sum-of-products form for boolean switching functions. Expanding on results previously reported the authors, introduce (1) an improved algorithm for converting a CSG expression to sum-of-products form, (2) a technique for minimizing the tree using don't care conditions based on geometry, (3) the dynamic interleaving of the above two algorithms, allowing very efficient rendering for most CSG objects, (4) a method for extending the technique to non-convex primitives, and (5) an implementation of these ideas in an interactive CSG design system on Pixelplanes 4. In this system the designer directly manipulates the CSG structure while continuously viewing the color rendering of the object under design. It is believed these algorithms will attain similar speeds on many of the next generation high-performance graphics system that have frame buffers with many bits per pixel. GRA

**N89-18153** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**THE ASPECT OF INFORMATION PRODUCTION IN THE PROCESS OF OBSERVATION**
Harald Atmanspacher Jun. 1988 41 p Submitted for publication
(MPE-Preprint-123; ETN-89-93803) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514 Eggenstein-Leopoldshafen 2, Fed. Republic of Germany

The physical process of observation is considered from an information theoretical viewpoint. Using the modified concept of an information based on infinite alternatives, a formalism describing the elementary transfer of one bit of information is derived. This bit of information is produced on a virtual (non-real) subquantum level of physical description. The interpretation of the formalism yields the following, complementary points: the effect of spatiotemporal delocalization on the subquantum level; and a possible access to the concept of chaos as an intrinsic property of quantum systems. Elementary information transfer is illustrated in a cosmological context. A formal approach to information production on the subquantum level is sketched on the basis of complex time. ESA

**N89-17741#** Wayne State Univ., Detroit, MI. Dept. of Mathematics.
**ON FUNCTIONAL APPROACH TO RANDOM WAVE PROPAGATION PROBLEMS**
P. L. Chow *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 6 p Sponsored by NSF, Washington, DC
(For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17742#** Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
**NUMERICAL SIMULATION OF WAVE PROPAGATION IN RANDOM MEDIA**
Mark Spivack *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 5 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17745#** Pennsylvania State Univ., University Park. Center for the Engineering of Electronic and Acoustic Materials.
**MULTIPLE SCATTERING OF WAVES IN RANDOM MEDIA CONTAINING NON-SPHERICAL SCATTERERS**
Vasundara V. Varadan, Vijay K. Varadan, and Yushieh Ma *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 8 p (For primary document see N89-17706 10-31)
(Contracts DAAG29-84-K-0187; DAAG29-85-K-0234)
Copyright Avail: NTIS HC A23/MF A01

**N89-17936#** Institut fuer Angewandte Geodaesie, Frankfurt am Main (Germany, F.R.).
**DETERMINATION OF PROXIMITY RELATIONS OF POINTS IN THREE DIMENSIONAL SPACE USING RASTER DATA PROCESSING [DIE BESTIMMUNG DER NACHBARSCHAFTSRELATIONEN VON PUNKTEN IN DREIDIMENSIONALEN RAUM MIT HILFE DER RASTERDATENVERARBEITUNG]**
Hans-Joerg Gottschalk *In its* Reports on Cartography and Geodesy, Series 1, Number 100 1988 p 5-20 In GERMAN; ENGLISH summary (For primary document see N89-17935 10-43)
Avail: NTIS HC A05/MF A01

# 65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

**N89-18154#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**ESTIMATION AND TESTING IN LARGE BINARY CONTINGENCY TABLES**
W. C. M. Kallenberg Mar. 1988 27 p
(MEMO-702; B8811732; ISSN-0921-1969; ETN-89-93823) Avail: NTIS HC A03/MF A01

Very sparse contingency tables with a multiplicative structure are studied. The number of unspecified parameters and the number of cells grow with the number of observations. Consistency and asymptotic normality of natural estimators are established. Uniform convergence of the estimators to the parameters is investigated, and an application to the construction of confidence intervals is presented. A family of godness-of-fit tests is proposed for testing multiplicativity. It is shown that the test statistics are asymptotically normal. The results can be applied in such different fields as production testing or psychometrics. ESA

**N89-18155#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**ON THE INDEPENDENCE OF INTEGER AND FRACTIONAL PARTS**
F. W. Steutel and J. G. F. Thiemann Oct. 1987 9 p
(MEMO-COSOR-87-29; ETN-89-93854) Avail: NTIS HC A02/MF A01

The independence of the integer and fractional parts of exponentially distributed random variables is used to obtain expressions for the order statistics from a geometric distribution. It is shown that a strong form of this independence characterizes the exponential distribution. ESA

**N89-18156#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**AGGREGATION-DISAGGREGATION ALGORITHMS FOR DISCRETE STOCHASTIC SYSTEMS**
Grzegorz Reyman and Jan vanderWal Oct. 1987 12 p
(MEMO-COSOR-87-30; ETN-89-93855) Avail: NTIS HC A03/MF A01

An aggregation-disaggregation method is formulated for a finite horizon Markov decision process with two-dimensional state and action spaces. This second dimension of the state and the action contains a similar type of information in which aggregation is both natural and simple. The quality of the approach is illustrated by an example. ESA

**N89-18157#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**HAIGHT'S DISTRIBUTION AND BUSY PERIODS**
F. W. Steutel and B. G. Hansen Jan. 1988 6 p
(MEMO-COSOR-88-01; ETN-89-93859) Avail: NTIS HC A02/MF A01

Haight's distribution as introduced by Letac and Seshadri (1988) is related to busy period distribution and generalized to a semigroup of infinitely divisible distributions. ESA

**N89-18158#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**THE GENERALIZED LOGARITHMIC SERIES DISTRIBUTION**
B. G. Hansen and E. Willekens Jan. 1988 10 p
(MEMO-COSOR-88-03; ETN-89-93861) Avail: NTIS HC A02/MF A01

It is shown that the generalized logarithmic series distribution is log-convex and hence infinitely divisible, and its Levy measure is determined asymptotically up to second order. An application to risk theory is given. ESA

**N89-18159#** Technische Hogeschool, Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**SYMBOLIC DYNAMICS FOR CIRCLE MAPS**
Jan Barkmeijer 1987 23 p
(ZW-8707; B8735743; ETN-89-93882) Avail: NTIS HC A03/MF A01

Circle maps with two critical points and which have a fixed point are studied using symbolic dynamics. It is shown that the dynamics of such a map is almost determined by the orbits of the critical points. For one parameter families of the set (f mu) mu is a member of (0,1) where only f0 and f1 are known, the dynamics of f mu for intermediate values of mu is discussed. ESA

**N89-18160#** Naval Underwater Systems Center, New London, CT. Submarine Sonar Dept.
**SIGNAL MODEL ANALYSIS VIA MODEL-CRITICAL METHODS**
Albert S. Paulson and Gerald R. Swope (Rensselaer Polytechnic Inst., Troy, NY.) 6 Oct. 1988 6 p
(AD-A200685; NUSC-8407) Avail: NTIS HC A02/MF A01 CSCL 12C

Model-critical procedures provided a means to scrutinize an assumed parametric statistical model by varying the way the data is processed for repeated fits to the model. The criticism of the data is accomplished using the generalized likelihood function for the assumed probability density of the data. The degree of criticism is controlled by a user specified constant c. The model-critical parameter estimates are obtained by maximization of the generalized likelihood function. When c = O, no criticism is performed and maximum likelihood estimates are obtained. These procedures can indicate if any model assumptions have been violated. Model critical estimation procedures are presented for autoregressive (AR) models. The analysis of an AR example is presented. GRA

**N89-18161#** North Carolina Univ., Chapel Hill. Dept. of Statistics.
**EXCHANGEABLE RANDOM MEASURES IN THE PLANE**
Olav Kallenberg Sep. 1988 71 p
(Contract F49620-85-C-0144)
(AD-A201055; TR-242; AFOSR-88-1193TR) Avail: NTIS HC A04/MF A01 CSCL 12C

The main purpose of this paper is to derive de Finetti-type representations of arbitrary separately or jointly exchangeable random measures. By this is meant representations of the distributions of xi as unique mixtures (convex combinations) of so called extreme exchangeable distributions. The existence of such integral representations is essentially a consequence of general theory so the author's main point is to describe the extreme measures explicitly. Through suitable Borel isomorphisms from the two spaces, one may easily reduce the problem to the special case when X and Y are real intervals, equipped with corresponding restrictions lambda and mu of Lebesgue measure (henceforth always denoted by lambda). GRA

**N89-17611#** Sverdrup Technology, Inc., Eglin AFB, FL. Operations Research Dept.
**STATISTICAL TECHNIQUES APPLIED TO ANALYSIS OF AIMPOINT DISTRIBUTIONS**
V. Darryl Thornton and Joseph M. Conrad *In* AGARD, Guidance and Control of Precision Guided Weapons Nov. 1988 8 p
(For primary document see N89-17605 10-15)
Copyright Avail: NTIS HC A05/MF A01

# 66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

No abstracts in this category.

# 67 THEORETICAL MATHEMATICS

Includes topology and number theory.

**N89-18162#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Mathematik.
**GROUP-THEORETICAL REPRESENTATION OF THE FANO AFFINE HJELMSLEV PLANES OVER LOCAL RINGS Ph.D. Thesis [GRUPPENTHEORETISCHE DARSTELLUNG DER FANOSCHEN AFFINE HJELMSLEVEBENEN UEBER LOKALEN RINGEN]**
Michael Gegenwart 1987 81 p In GERMAN
(ETN-89-93500) Avail: NTIS HC A05/MF A01

Affine planes, related to Hjelmslev S-groups, were group theoretically represented over local rings. Local rings and their spaces, metric spaces over local rings, Clifford algebra and produced projected Clifford groups, and affine Hjelmslev planes are introduced. The existence of Hjelmslev S-groups with affine Hjelmslev planes as group planes, their characterization by axioms, as well as their properties are discussed. Extended imaging groups are presented. A geometrical intepretation of H-S groups, deduced from the concept incidence group, is given. Orthogonal groups and projective imaging groups are explained. ESA

**N89-18163#** Technische Hogeschool Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**REPRESENTING A NONLINEAR STATE SPACE SYSTEM AS A SET OF HIGHER-ORDER DIFFERENTIAL EQUATIONS IN THE INPUTS AND OUTPUTS**
A. J. vanderSchaft Mar. 1988 14 p
(MEMO-698; B8811728; ISSN-0921-1969; ETN-89-93819) Avail: NTIS HC A03/MF A01

An algorithm for transforming a nonlinear state space system into a threefold set of equations is presented. The first subset describes the dynamics of the unobservable part of the system. The second subset represents the remaining state variables as functions of inputs and outputs and their derivatives. The last subset defines the external behavior of the system. ESA

**N89-18164#** International Centre for Theoretical Physics, Trieste (Italy).
**ASYMPTOTIC BEHAVIOUR OF ALMOST NON EXPANSIVE SEQUENCES IN A HILBERT SPACE**
Behsad DjafariRouhani Aug. 1988 11 p
(DE88-704732; IC-88/188) Avail: NTIS (US Sales Only) HC A03/MF A01

The results for non expansive sequences are generalized to almost non expansive sequences in a Hilbert space, and using this notion a direct proof of a result of H. Bresis and F.E. Browder is given. DOE

**N89-18165#** International Centre for Theoretical Physics, Trieste (Italy).
**HILBERT SPACE STRUCTURE ON BANACH ALGEBRAS**
Noor Mohammad and A. B. Thaheem Aug. 1988 6 p
(DE88-704745; IC-88/222) Avail: NTIS (US Sales Only) HC A02/MF A01

In this note we define an inner product on reduced Banach *-algebras via a measure on the set of positive functionals. It is shown here that the resultant inner product space is a topological algebra and also a completeness condition is obtained. DOE

# 70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

**N89-18166#** Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimentalnoj.
**INSTALLATION WITH MAGNETIC SUSPENSION OF TEST BODIES FOR MEASUREMENT OF SMALL FORCES. VERIFICATION OF EQUIVALENCE OF INERTIAL AND GRAVITATIONAL MASS. DISCUSSION OF THE METHOD [ROZHDENIE KUMULYATIVNYKH K+-MEZONOV PROTONAMI A EHNERGIEJ 10 GEHV]**
S. M. Kalebin 1988 17 p In RUSSIAN
(DE88-704810; ITEF-24(1988)) Avail: NTIS (US Sales Only) HC A03/MF A01

Torsion installation with magnetic suspension of test bodies for detection of small forces is considered. Installation application for verification of equivalence of inertial and gravitational mass in the case of test body incidence on the Earth (Etvesh experiment) and in the case of their incidence on the Sun (Dicke experiment) is discussed. The total mass of test bodies, produced in the form of cylinders with 3 cm radius, equals 50 kg (one lead body and one copper body); beam radius of test bodies equals 3 cm (the cylinders are tight against one another); ferrite cylinder with 3 cm radius and 10 cm height is used for their suspension in magnetic field. Effect of thermal noise and electromagnetic force disturbances on measurement results is considered. Conducted calculations show that suggested installation enables one to improve the accuracy of verifying mentioned equivalence at least by one order and upwards. This suggests that such installation is a matter of interest for experiments on small force detection. DOE

# 71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

**N89-18167*#** Cornell Univ., Ithaca, NY. School of Mechanical and Aerospace Engineering.
**HELICOPTER TAIL ROTOR BLADE-VORTEX INTERACTION NOISE Final Technical Report, 1 Feb. 1986 - 31 Mar. 1987**
Albert R. George and S.-T. Chou Mar. 1987 28 p

(Grant NAG2-379)
(NASA-CR-183178; NAS 1.26:183178) Avail: NTIS HC A03/MF A01 CSCL 20A

A study is made of helicopter tail rotor noise, particularly that due to the interactions with main rotor tip vortices. Summarized here are present analysis, the computer codes, and the results of several test cases. Amiet's unsteady thin airfoil theory is used to calculate the acoustics of blade-vortex interaction. The noise source is modelled as a force dipole resulting from an airfoil of infinite span chopping through a skewed line vortex. To analyze the interactions between helicopter tail rotor and main rotor tip vortices, we developed a two-step approach: (1) the main rotor tip vortex system is obtained through a free wake geometry calculation of the main rotor using CAMRAD code; (2) acoustic analysis takes the results from the aerodynamic interaction analysis and calculates the farfield pressure signatures for the interactions. It is found that under a wide range of helicopter flight conditions, acoustic pressure fluctuations of significant magnitude can be generated by tail rotors due to a series of interactions with main rotor tip vortices. This noise mechanism depends strongly on the helicopter flight conditions and the relative location and phasing of the main and tail rotors. fluctuations of significant magnitude can be generated by tail rotors due to a series of interactions with main rotor tip vortices. This noise mechanism depends strongly upon the helicopter flight conditions and the relative location and phasing of the main and tail rotors. Author

**N89-18168#** Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.
**REFLECTION OF ION-ACOUSTIC WAVES FROM BIPOLAR POTENTIAL STRUCTURES**
Y. Nakamura and Joyanti Chutia Jul. 1988 17 p
(ISAS-632; ISSN-0285-6808) Avail: NTIS HC A03/MF A01

Reflection of the ion-acoustic waves from the ion sheath in front of the separation grid in a double plasma device was investigated experimentally. The plasma potential theta of the source plasma was controlled against the target plasma. When e theta is less then -kappa T sub e, where T sub e is the electron temperature, no reflection was observed. The reason of this is that ions are drifting toward the grid with the Bohm velocity, i.e., the ion-acoustic velocity. When c theta is less than kappa T sub e, the reflected wave consists of the ion-acoustic wave and the ion beam mode. The reflection coefficient for the ion-acoustic wave is about unity. This high efficiency is due to reflection of the ions themselves. Author

**N89-18169#** National Bureau of Standards, Gaithersburg, MD. Ultrasonic Standards Group.
**ULTRASONIC MEASUREMENTS RESEARCH: PROGRESS IN 1988 Annual Summary Report, 1 Oct. 1987 - 31 Sep. 1988**
F. R. Breckenridge, T. M. Proctor, N. N. Hsu, S. E. Fick, and D. G. Eitzen 29 Jul. 1988 13 p
(Contract N00014-88-L-0006)
(AD-A201133) Avail: NTIS HC A03/MF A01 CSCL 20A

Progress is described on the design of a system for secondary calibration of acoustic emission transducers. Experimental secondary calibrations indicate that a 3.3 cm thick steel plate is not a suitable transfer block, and that the transfer block should be more like a semi-infinite medium. Simulated acoustic emission sources have been studied theoretically and experimentally. Hertzian impact experiments have been carried out, and source waveforms have been reconstructed from experimental data using an inverse Green's function for the plate. Moderate agreement was obtained between Hertzian theory and the experimental results. GRA

**N89-17737#** Cambridge Univ. (England). Ocean Acoustics Group.
**INTENSITY FLUCTUATIONS DUE TO MOVING POINT SOURCES**
B. J. Uscinski *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 7 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17740#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Electrical Engineering.
**ON THE APPLICABILITY OF CONTINUOUS SCATTERING METHODS TO DISCRETE SCATTERING PROBLEMS**
Ioannis M. Besieris *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 6 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17927#** Joint Publications Research Service, Arlington, VA.
**SOUND RADIATION BY EDDIES, ACOUSTIC INSTABILITY AND ACOUSTIC COLLAPSE Abstract Only**
V. M. Gryanik *In its* JPRS Report: Science and Technology. Science and Technology. USSR: Earth Sciences 8 Sep. 1988 p 12 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery I Okeana (Moscow, USSR), v. 24, no. 5, May 1988 p 513-519 (For primary document see N89-17907 10-42)
Copyright Avail: NTIS HC A03/MF A01

# 72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

**N89-18170#** Sandia National Labs., Albuquerque, NM.
**ARGON ION BOMBARDMENT DURING MOLECULAR BEAM EPITAXY OF Ge(001)**
Eric Chason, K. M. Horn, J. Y. Tsao, and S. T. Picraux 1988 5 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 28 Nov. 1988
(Contract DE-AC04-76DP-00789)
(DE89-004378; SAND-88-1644C; CONF-881155-16) Avail: NTIS HC A02/MF A01

Using in situ, real-time reflection high energy electron diffraction (RHEED), we have measured the evolution of Ge (001) surface morphology during simultaneous molecular beam epitaxy and Ar ion beam bombardment. Surprisingly, low-energy Ar ions during growth tend to smoothen the surface. Bombardment by the ion beam without growth roughens the surface, but the surfaces can be reversibly smoothened by restoring the growth beam. We have measured the effect of such ion beam growth smoothening above and below the critical temperature for intrinsic growth roughening. At all measured growth temperatures the surface initially smoothens but below the critical roughening temperature the final surface morphology is rough whereas above this temperature the final morphology is smooth. DOE

**N89-18171#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Physik.
**INVESTIGATION OF THE MASS AND ENERGY DISTRIBUTION OF NEUTRON-INDUCED FISSION OF URANIUM 235 IN THE DOMAIN OF DECOMPOSED RESONANCES Ph.D. Thesis [UNTERSUCHUNG DER MASSEN- UND ENERGIEVERTEILUNG DER NEUTRONENINDUZIERTEN SPALTUNG VON 235 U IM BEREICH AUFGELOESTER RESONANZEN]**
Franz-Joseph Hambsch Jun. 1987 178 p In GERMAN
(ETN-89-93501) Avail: NTIS HC A09/MF A01

The fluctuations in the mass and energy distribution of the fission fragments of the reaction 235 U(n,f) were investigated. The role of spin resonance in the theoretical description of the fission cross section is outlined. The measurements of the cross section as well as the problems of the spin determination in actinides are presented. The experiments in the neutron energy range of the resonances are interpreted, and a model for fission processes is described. The experimental data are presented as a function of the neutron energy of the reaction 235 U(n,f). The correlation between fluxes in mass production, total kinetic energy, and fluctuations in other fission parameters is discussed. The correlation between the ratio of symmetric and asymmetric mass

production and the angular distribution of oriented fragments is discussed. The measured fission parameter distributions are described with the model of Brosa, Grossmann and Mueller.
ESA

**N89-18172#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Physik.
**ELECTRON-POSITRON PAIR PRODUCTION DURING THE COLLISION OF NONRELATIVISTIC CHARGED PARTICLES Ph.D. Thesis [ELEKTRON-POSITRON-PAARPRODUKTION BEIM STOSS NICHTRELATIVISTISCHER GELADENER TEILCHEN]**
Bernd Arno Nikolaus 1987 145 p In GERMAN
(ETN-89-93507) Avail: NTIS HC A07/MF A01

Pair production during the collision of nonrelativistic particles was investigated, starting from the discrepancy between theoretical predictions and experimental results. Projectile-target combinations with very different atomic charge and projectile energies just above the reaction threshold of 1.022 MeV were considered. The calculations show that at the threshold the pair production cross section is strongly reduced, such that the theoretical predictions are orders of magnitude below the experimental results. ESA

**N89-18173#** Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Inst. Atomnoj Ehnergii.
**KINETICS OF HYDROGEN ISOTOPE MESIC ATOMS IN EXCITED STATES**
L. I. Menshikov 1987 19 p In RUSSIAN
(DE88-704686; IAE-4531/12) Avail: NTIS (US Sales Only) HC A03/MF A01

The mechanisms of de-excitation and acceleration of mesic atoms of hydrogen isotopes in excited states are studied. New results for Auger transitions rates are given. The energy distribution of mesic atoms for the transition to 1S state is calculated. DOE

**N89-18174#** International Centre for Theoretical Physics, Trieste (Italy).
**ON THERMOPOWER CALCULATIONS WITH TEMPERATURE DEPENDENT ELECTRON ENERGIES**
P. N. Butcher and L. P. Zvyagin Aug. 1988 4 p Submitted for publication
(DE88-704744; IC-88/221) Avail: NTIS (US Sales Only) HC A02/MF A01

It is argued that the thermoeletric transport coefficients in a coupled electron-phonon system depend on the interaction of phonons with a heat bath. When the phonon mean free path is short, the temperature dependent energy levels may be introduced in the Boltzmann equation which yields the usual formulae for the thermopower with temperature dependent energies inserted. For weak phonon-heat bath interaction and strong electron-phonon interaction the transport equation is obtained for new quasiparticles and the energy current includes the transport of the electron-phonon energies carried along by a quasiparticle. DOE

**N89-18175#** Wisconsin Univ., Madison. Dept. of Physics.
**PRODUCTION OF ATOMIC AND MOLECULAR RADIATION BY ELECTRON IMPACT Final Report, 8 Jan. 1987 - 8 Jun. 1988**
Chun C. Lin 8 Sep. 1988 45 p
(Contract F19628-87-K-0017)
(AD-A200620; AFGL-TR-88-0155) Avail: NTIS HC A03/MF A01 CSCL 20E

Electron impact excitation cross sections of the 1 sigma (+) sub u yields a 1 Pi sub g emission band of N2 molecules involving different vibrational quantum numbers has been measured. Excitation of the vibrational levels of the c'sub 4 state is analyzed in terms of the Franck Condon factors and perturbation by the b'1 sigma (+) sub u state. Nonlinearity in the pressure dependence of the emission signal is studied. Optical cross sections have been measured for emission lines of 04 ions produced by electron impact on 02 molecules. GRA

**N89-18176#** Queens Univ., Belfast (Northern Ireland). Dept. of Applied Mathematics and Theoretical Physics.
**THEORETICAL STUDIES OF ATOMIC AND MOLECULAR PROCESSES IMPORTANT IN SPACE EXPERIMENTS Final Report, 1 Apr. 1987 - 31 Mar. 1988**
David R. Bates Jun. 1988 17 p
(Grant AF-AFOSR-0202-85; AF Proj. 7661)
(AD-A200699; AFGL-TR-88-0158) Avail: NTIS HC A03/MF A01 CSCL 20H

Calculations have been carried out on the photoionization of OII (4S0, 2D0, and 2P0) and on the photoionization of NI (4S0, 2D0, and 2P0). An explanation has been advanced for the enhanced abundance of heavy ozone in the stratosphere. A published proposal for resolving the apparent ozone deficiency in the region above the 95 km level has been examined and shown to be unsatisfactory. A method has been devised whereby the low density limit to the rate coefficient for the termolecular association of ions and polar molecules may be found from measurements on the rate coefficient even outside the region where third order kinetics prevail. The theory of radiative association when the stabilization is brought about by an electronic transition has been developed. GRA

# 73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

**N89-18177#** Department of Energy, Washington, DC. Office of Nuclear Energy.
**IMPORTANT TECHNOLOGY CONSIDERATIONS FOR SPACE NUCLEAR POWER SYSTEMS**
John P. Kuspa, Earl J. Wahlquist, and Dennis A. Bitz Mar. 1988 28 p
(DE89-004005; DOE/NE-0093) Avail: NTIS HC A03/MF A01

This paper discusses the technology considerations that guide the development of space nuclear power sources (NPS) by the Department of Energy (DOE) to meet a wide variety of applications. The Department and its predecessor agencies have been developing NPS since the 1950s and producing NPS for spacecraft for the National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD) since the early 1960s. No one nuclear power type, isotope or reactor, will suffice over the entire range of mission power required. Nor is one type of power conversion system, be it static or dynamic, the optimum choice of all space nuclear power system applications. There is a need for DOE, in partnership with its users, NASA and DOD, to develop a variety of types of space nuclear power sources - isotope-static, isotope-dynamic, reactor-static, and reactor-dynamic - to meet mission requirements well into the next century. DOE

**N89-18178#** Department of Energy, Washington, DC.
**ENVIRONMENTAL ASSESSMENT OF SP-100 GROUND ENGINEERING SYSTEM TEST SITE: HANFORD SITE, RICHLAND, WASHINGTON**
Dec. 1988 279 p
(DE89-004400; DOE/EA-0318) Avail: NTIS HC A13/MF A01

The US Department of Energy (DOE) proposes to modify an existing reactor containment building (decommissioned Plutonium Recycle Test Reactor (PRTR) 309 Building) to provide ground test capability for the prototype SP-100 reactor. The 309 Building (Figure 1.1) is located in the 300 Area on the Hanford Site in Washington State. The National Environmental Policy Act (NEPA) requires that Federal agencies assess the potential impacts that their actions may have on the environment. This Environmental Assessment describes the consideration given to environmental impacts during reactor concept and test site selection, examines the environmental effects of the DOE proposal to ground test the nuclear subsystem, describes alternatives to the proposed action,

and examines radiological risks of potential SP-100 use in space. DOE

**N89-18179#** Stanford Univ., CA.
**THE APPLICATION OF CHANNELING RADIATION TO THE STUDY OF MATERIALS AND THE DEVELOPMENT OF X-RAY AND GAMMA-RAY SOURCES Final Report, 1 Aug. 1986 - 30 Nov. 1987**
Richard H. Pantell Nov. 1988 11 p
(Grant AF-AFOSR-0236-86; AF Proj. 2917)
(AD-A200743; AFOSR-88-1120TR) Avail: NTIS HC A03/MF A01 CSCL 20G

The equipment purchased under this grant has been used to construct a beamline for developing an X-ray source based upon channeling radiation. The beamline has been added to the Stanford, Mark III linear accelerator, which provides a high current, low emittance electron beam at approximately 40 MeV energy. GRA

**N89-18180#** Lawrence Livermore National Lab., CA.
**PACER REVISITED**
Ralph W. Moir 18 Nov. 1988 6 p Presented at the 8th Topical Meeting on Technology of Fusion Energy, Salt Lake City, UT, 9-13 Oct. 1988 Submitted for publication
(Contract W-7405-eng-48)
(DE89-004878; UCRL-98468-Rev-1; CONF-881031-22-Rev-1)
Avail: NTIS HC A02/MF A01

This paper discusses a modified version of the PACER concept for power and nuclear material production. In the PACER concept, a 20-kt peaceful nuclear explosion is contained in a cavity about 200 m in diameter, filled with 200 atom of 500 C steam. Energy from the explosion is used to produce power, and the neutrons are used to produce materials such as U-233. The present idea is to modify the PACER concept in three ways to improve the practicality, predictability, and safety of power production from this technology and thus improve public acceptance of this power source. These improvements are: (1) line the cavity with steel; (2) replace the steam with molten salt, LiF + BeF2; and (3) reduce the explosive yield to about 2 kt. PACER is the only fusion power concept where the underlying technology of the power source itself is proven and in hand today. The molten-salt shock-suppression and heat transport system and the durability of the underground cavity need demonstration. DOE

## 74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers.*

**N89-18181#** Lightning Sciences, Inc., Scottsdale, AZ.
**RESEARCH AND DEVELOPMENT OF A STATIC OPTICAL SYSTEM TO REDUCE APPARENT MOTION OF THE SUN Final Report**
30 Nov. 1988 84 p
(Contract DE-AC03-87SF-17301)
(DE89-004152; DOE/SF-17301/T1) Avail: NTIS HC A05/MF A01

This project has been undertaken to develop an optimum design for lensing which will reduce the apparent daily and seasonal motion of the sun. The goal of the work has been to produce a lens onto which sunlight falls over its wide range of angles, yet have the transmitted light lie within a restricted angular range. Using computer simulations, a large number of optical designs have been investigated, both complex and simple. Lenses were evaluated in terms of the lumens transmitted and the uniformity of transmission during the working day and throughout the year. Lens designs which provide very high transmittance were discovered, but it has been found that the period of transmittance is only a few hours per day. Other designs were developed with only a moderate transmitting efficiency, but which produce light in the useful angular range over virtually all of the day without major fluctuations. The effect of seasonal variation on such lenses also has been evaluated. Performance analysis has been presented for all lenses found to have useful characteristics, and the researchers believe that different lenses will perform best depending upon the nature of the application. However, it has been determined after detailed analysis that a relatively simple form of lens will outperform complex designs for most applications. DOE

**N89-18182#** Lightning Sciences, Inc., Scottsdale, AZ.
**RESEARCH AND DEVELOPMENT OF A STATIC OPTICAL SYSTEM TO REDUCE APPARENT MOTION OF THE SUN: APPENDICES Final Report**
30 Nov. 1988 83 p
(Contract DE-AC03-87SF-17301)
(DE89-004153; DOE/SF-17301/T1-App) Avail: NTIS HC A04/MF A01

This is the Appendices to the report, Research and Development of a Static Optical System to Reduce Apparent Motion of the Sun. Design cross sections that were tested are given. DOE

**N89-18183#** Los Alamos National Lab., NM. Materials Science and Technology Div.
**REFLECTANCE OF ALUMINUM REFLECTORS IN THE EXTREME ULTRAVIOLET**
Marion L. Scott 1988 7 p Presented at the 4th Topical Meeting on Short Wavelength Coherent Radiation: Generation and Applications, Cape Cod, MA, 26 Sep. 1988
(Contract W-7405-eng-36)
(DE89-002126; LA-UR-88-3436; CONF-880904-3) Avail: NTIS HC A02/MF A01

We have investigated a new concept in retro-reflectors for use in the extreme ultraviolet, namely, uhv aluminum coated, multi-facet, grazing-incidence mirrors. Our results indicate that this type of mirror, which utilizes total-external-reflectance, works very well in the wavelength range from 35 nm to 100 nm (89+-3 percent measured retroreflectance at 58.4 nm for a 9-facet mirror). However, the coated mirror surfaces must not be allowed to oxidize after deposition, which implies that the retro-reflector must be coated and used in situ or the oxide layer must be removed in a ultra-high vacuum (uhv) system. DOE

**N89-18184#** California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Chemical Sciences Div.
**NONLINEAR OPTICAL TECHNIQUES FOR SURFACE STUDIES**
Y. R. Shen Jul. 1988 33 p Presented at the Spectroscopic and Diffraction Techniques in Interfacial Electrochemistry, Puerto de la Cruz, Spain, 3 Jul. 1988
(Contract DE-AC03-76SF-00098)
(DE89-002925; LBL-25002; CONF-880732-2) Avail: NTIS HC A03/MF A01

Second-order nonlinear optical effects have recently been proven to be an extremely versatile analytical tool for surface studies. They are forbidden in media with centrosymmetry and hence, highly surface specific. Being coherent optical techniques, they have high temporal, spatial, and spectral resolution, and are useful for experiments requiring in-situ probing and remote sensing. They also have the advantage of being applicable to any interface accessible by light. In these lectures, we shall give a general review on the development of such techniques. We first present the underlying theory of a second-order optical process at an interface. We then discuss, with examples, the various possible applications of second harmonic and sum-frequency generation for surface studies. DOE

**N89-18185#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Physik.
**OPTICAL COUPLING IN VOLUME HOLOGRAMS Ph.D. Thesis [STRAHLKOPPLUNG IN VOLUMENHOLOGRAMMEN]**
Joachim Goltz 1987 83 p In GERMAN
(ETN-89-93503) Avail: NTIS HC A05/MF A01

A model in order to simplify the mathematical description of light propagation in periodic media was developed. The model is based on the division of the volume in thin disks, and on the use

of the amplitude transmission theory. For radiation in the Bragg domain, all diffraction orders except orders zero and one contain little energy and can be neglected. The model directly leads to the optical coupling equations and can be applied to isotropic (e.g., volume holograms of pictures) and anisotropic media (e.g., helix-like arranged liquid crystals), as is demonstrated with significant examples, especially optical coupling in photorefractive crystals. The theoretical results were verified by experiments. ESA

**N89-18186#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Physik.
**NEW METHODS FOR THE PRODUCTION OF HIGH GRADE OPTICAL COATINGS Ph.D. Thesis [NEUE METHODEN ZUR HERSTELLUNG HOCHWERTIGER OPTISCHER BESCHICHTUNGEN]**
Hans-Peter Vietze 1988 118 p In GERMAN
(ETN-89-93508) Avail: NTIS HC A06/MF A01

The physically relevant aspects of technologies and procedures for the production of high grade optical coatings are reviewed. The fundamentals, the technical setup, and the film properties of vapor deposition and ion beam sputtering are described. The microstructure of both layers are compared. The sputtered films have a higher refraction index and a more homogeneous morphology. A method to measure the absorption of the produced mirrors, based on the high power densities in the laser resonator, was developed. It is simpler and more sensitive than conventional calorimetry. The absorption measurements also show the superior quality of the ion beam sputtered films. Investigations for the evaluation of the ionized cluster beam technology were started. ESA

**N89-18187#** Research Inst. of National Defence, Linkoeping (Sweden). Dept. of Information Technology.
**NONLINEAR OPTICS AND OPTICAL COMPUTERS**
Ingmar Renhorn Aug. 1988 39 p In SWEDISH; ENGLISH summary
(FOA-C-30500-3.1; ISSN-0347-3708; ETN-89-93741) Avail: NTIS HC A03/MF A01; Swedish Defense Research Establishment, Box 1165, S-581 11, Linkoping, Sweden, 50 Swedish crowns

Computer processing requirements in areas like radar and solar signal processing: spectrum analysis of broadband signals, sensor fusion, pattern recognition, and expert systems are reviewed. The capability of conventional computer technology is insufficient. Limitations are due to a combination of computing requirements, size, weight, and power. Optical systems for information processing were developed. The combined progress in light modulators, nonlinear crystals, computer generated holograms, improved filter technology, and improved handling of the output data is noted. The interest for optical neural computers, composed of thresholding elements and neural nets, with a very large optical memory, increased strongly. ESA

**N89-18188#** Ecole Nationale Superieure des Telecommunications, Paris (France). Dept. Image.
**TREATMENT OF OPTICAL SIGNALS. NONLINEAR OPTICS (RAMAN EFFECT) [TRAITEMENT DES SIGNAUX OPTIQUES. OPTIQUES NON LINEAIRE (EFFET RAMAN)]**
Laurent Boyer 1988 96 p In FRENCH
(ENST-88H004; ISSN-0751-1361; ETN-89-94108) Avail: NTIS HC A05/MF A01

Research in optical data processing, including associated memories networks, Hoppfield neuronal model, optical interconnection networks, and achromatic Fourier transform is reviewed. In nonlinear optics, second harmonic generation and stimulated Raman diffusion are studied. ESA

**N89-18189#** Rochester Univ., NY. Inst. of Optics.
**POPULATION PULSATIONS AND THE DYNAMIC STARK EFFECT**
Robert W. Boyd and Murray Sargent, III (Arizona Univ., Tucson.) Jan. 1988 14 p Repr. from Journal of Optical Socity of America B, Vol. 5, No. 1, Jan. 1988 p 99-111
(Contract DAAL03-86-K-0173)
(AD-A200731; ARO-24626.45-PH-UIR) Avail: NTIS HC A03/MF A01 CSCL 20F

We present a theoretical description of the interaction of optical waves due to the resonant nonlinear response of an atomic system. We emphasize how the resonant nature of the nonlinear coupling is modified by the shifting of the atomic energy levels as a consequence of the dynamic Stark effect and show the equivalent role played by population pulsations in determining the nature of the nonlinear coupling. A general formalism is developed to treat these effects and is explicitly applied to several examples of current interest, including single-beam saturation spectroscopy, pump-probe saturation spectroscopy, degenerate four-wave mixing for phase conjugation, and instabilities in the beam propagation through resonant media. GRA

**N89-18190#** Environmental Research Lab., Athens, GA. Image Processing Systems Div.
**COMPACT COHERENT OPTICAL CORRELATOR SYSTEM Final Report, 9 Jan. 1985 - 29 Feb. 1988**
Juris Upatnieks and James O. Abshier May 1988 84 p
(Contract DAAH01-85-C-1144)
(AD-A200769; ERIM-190200-51-F) Avail: NTIS HC A05/MF A01 CSCL 20F

A real-time coherent optical correlator was designed, fabricated and tested. The correlator features 30 separate filters, low-light level real-time operation, and a compact design. The correlator is packaged in a cylinder 15 cm in diameter by 30 cm long, excluding imaging lens. Each of the two laser diode coherent light sources is imaged to 15 locations with holographic optical elements (HOEs). The HOEs perform a number of functions usually requiring several optical components. The HOEs correct the aspect ratio of the laser diode beams, perform the functions of collimating and Fourier transform lenses, multiplex the light beam to form multiple Fourier transforms, and correct a variety of system aberrations. Low-light operation is achieved with a microchannel image intensifier in front of a liquid crystal light modulator. This arrangement allows the correlator to operate over a wide range of light levels, from full sunlight to dusk. The image intensifier, however, reduces system resolution and response time. A computer controlled filter maker system was designed to automate filter recording. The computer, a small PC-type, controls the position of the recording plate, the reference beam angle, dwell and exposure times, and checks light source and shutter operation. GRA

**N89-18191#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**DESIGN OF A WAFER-SCALE FOCAL PLANE PROCESSOR**
P. C. Trepagnier 15 Sep. 1988 48 p
(Contract F19628-85-C-0002)
(AD-A200937; TR-814; ESD-TR-88-173) Avail: NTIS HC A03/MF A01 CSCL 17E

This report describes a wafer-scale design for an infrared Focal Place Processor (FPP) to operate in a space environment. The functions of a generic Focal Plane Processor are described, followed by a detailed discussion of a design to be implemented in RVLSI wafer-scale technology for a space-based application. A prototype of this processor (PFPP) will actually be fabricated in rad-hard silicon-on-insulator 3-micrometers technology. Finally, the question of reliability is explored, and a philosophy of fault tolerance is presented which will lead to a reasonable probability of success over a five-year lifetime. GRA

**N89-18192#** University of Southern California, Los Angeles. Optical Materials and Devices Lab.
**INTEGRATED OPTICAL INFORMATION PROCESSING Final Report, 1 Sep. 1985 - 31 Aug. 1987**
Armand R. Tanguay, Jr. Aug. 1988 251 p
(Grant AF-AFOSR-0312-85; AF Proj. 2305)
(AD-A201016; USC-OMDL-1901; AFOSR-88-0994TR) Avail: NTIS HC A12/MF A01 CSCL 17I

The principal objective of this research program was the advancement of novel integrated optical and optoelectronic device

technology suitable for inherently nonplanar optical information processing applications. As a first demonstration, a compact, low cost, low power optical Synthetic Aperture Radar (SAR) processor was investigated for real time image formation aboard airborne and spaceborne platforms. The key to implementation of the integrated optical SAR processor is the use of a time- and space-integrating architecture, which allows two-dimensional processing to be performed with inherently one-dimensional signal processing devices. This permits the monolithic or hybrid integration of all of the necessary components into a single compact structure. An additional novel feature of this concept is the utilization of partial waveguide confinement (selective outcoupling) to achieve either uniform or modulated light emission vertically out of the integrated optical substrate plane. This feature in turn permits the realization of three dimensional optical signal processing architectures. GRA

**N89-18193#** Argonne National Lab., IL.
**VARIABLE FOCUS CRYSTAL DIFFRACTION LENS**
R. K. Smither Nov. 1988 23 p Presented at the 3d International Conference on Synchrotron Radiation Instrumentation, Tokyo, Japan, 29 Aug. - 2 Sep. 1988
(Contract W-31-109-eng-38)
(DE89-005885; CONF-8808141-10) Avail: NTIS HC A03/MF A01

A new method has been developed to control the shape of the surface of a diffracting crystal that will allow it to function as a variable focus crystal diffraction lens, for focusing photon beams from a synchrotron source. The new method uses thermal gradients in the crystal to control the shape of the surface of the crystal in two dimensions and allows one to generate both spherical and ellipsoidal surface shapes. In this work the thermal gradient was generated by core drilling two sets of cooling channels in a silicon crystal so that cooling or heating fluids could be circulated through the crystal at two different levels. The first set of channels is close to the surface of the crystal where the photon beam strikes it. The second set of channels is equal distant from the back surface. If a concave surface is desired, the fluid in the channels just below the surface exposed to the beam is cooler than the fluid circulating through the channels near the back surface. If a convex surface is desired, then the cooling fluid in the upper channels near the surface exposed to the incident photon beam, is warmer than the fluid in the lower channels. The focal length of the crystal lens is varied by varying the thermal gradient in the crystal. This approach can also be applied to the first crystal in a high power synchrotron beam line to eliminate the bowing and other thermal distortions of the crystal caused by the high heat load. DOE

**N89-17707#** Fondazione Ugo Bordoni, Rome (Italy).
**COUPLED-MODE THEORY APPROACH TO DEPOLARIZATION ASSOCIATED WITH PROPAGATION IN TURBULENT MEDIA**
B. Crosignani and P. DiPorto *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 5 p Prepared in cooperation with Aquila Univ., Italy (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17708#** Washington Univ., Seattle. Dept. of Electrical Engineering.
**EXPERIMENT AND THEORY FOR BACKSCATTERING ENHANCEMENT AND IMAGING IN RANDOM MEDIA**
Akira Ishimaru and Yasuo Kuga *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 10 p Sponsored in part by Army Research Office, Washington, DC and NSF, Washington, DC (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17711#** Rome Air Development Center, Hanscom AFB, MA. Electromagnetics Directorate.
**REGIONS OF VALIDITY FOR SOME ROUGH SURFACE SCATTERING MODELS**
Robert J. Papa and John F. Lennon *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 16 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17716#** Nebraska Univ., Lincoln. Dept. of Electrical Engineering.
**MULTIPLE SCATTERING EFFECTS OF RANDOM DISTRIBUTIONS OF IRREGULARLY SHAPED PARTICLES ON INFRARED AND OPTICAL PROPAGATION**
Ezekiel Bahar and Mary Ann Fitzwater *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 15 p (For primary document see N89-17706 10-31)
(Contract DAAG29-82-K-0123; NSF ECS-85-15794)
Copyright Avail: NTIS HC A23/MF A01

**N89-17718#** Royal Signals and Radar Establishment, Malvern (England).
**GENERATION AND PROPERTIES OF SELF-SIMILAR STOCHASTIC PROCESSES WITH APPLICATION TO RAY PROPAGATION IN RANDOM MEDIA**
J. H. Jefferson and J. D. Anderson *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 19 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17721#** Office National d'Etudes et de Recherches Aeronautiques, Paris (France).
**OPTICAL IMAGERY ACROSS ATMOSPHERIC TURBULENCE [IMAGERIE OPTIQUE A TRAVERS LA TURBULENCE ATMOSPHERIQUE]**
G. Rousset, J. C. Fontanella, J. Primot, and A. Seve *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 13 p In FRENCH Previously announced in IAA as A87-46754 (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-17722#** British Aerospace Public Ltd. Co., Bristol (England). Naval and Electronic Systems Div.
**INFRARED ATMOSPHERIC TRANSMISSION/EMISSION MEASUREMENT IN A MARITIME ENVIRONMENT**
G. J. Bishop and I. W. Larkin *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 12 p Sponsored by Ministry of Defence, United Kingdom (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

**N89-18390*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**CRYOGENIC MIRROR ANALYSIS**
S. Nagy *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 69-103 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 20F

# 75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

**N89-18194#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Physik.
**OPTICAL SCHLIEREN METHOD WITH HIGH SPATIAL AND TEMPORAL RESOLUTION FOR THE INVESTIGATION OF INSTABILITIES IN NONEQUILIBRIUM PLASMAS Ph.D. Thesis [OPTISCHES SCHLIERENVERFAHREN MIT HOHER ORTS- UND ZEITAUFLOESUNG ZUR UNTERSUCHUNG VON INSTABILITAETEN IN NICHTGLEICHGEWICHTSPLASMEN]**
Claus Ruediger Haas 1987 117 p In GERMAN
(ETN-89-93496) Avail: NTIS HC A06/MF A01

An optical Schlieren system was built as an active diagnostic for the determination of plasma electron density modulations in nonequilibrium plasmas (e.g., plasma focus). A mode-coupled dye

laser was used as light source; together with a stroboscopic recording technique, it provides complete information about the dynamics of the collapsing plasma layer. The spatial resolution is better than 10 micron, the temporal resolution is better than 100ps. A periodic density modulation is observed and, in connection with available models, identified as the lower hybrid drift instability. The stroboscopic technique allows to follow hydrodynamic instabilities during collapse and focus phase, and hence to determine the growth rate of the Rayleigh-Taylor and the zero order poloidal instability in good agreement with model calculations. A model was developed for the noncylindrical, axisymmetric focus plasma, for the interpretation of the Schlieren pictures. ESA

**N89-18195#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**IMPURITY PELLET INJECTION INTO CURRENT-DRIVEN PLASMAS OF THE JIPPT-IIU TOKAMAK**
S. Morita, E. Kawatoh, K. Ohkubo, K. Ida, Y. Ogawa, K. Adati, T. Amano, Junji Fujita, Y. Hamada, and S. Hidekuma et al Dec. 1988 24 p
(IPPJ-894; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

Impurity pellets of stainless steel and plastic carbon with a size of 0.5 mm diameter and a velocity of 400 + or - 100 m/s have been injected into fast-wave-current-driven plasma with a sustained plasma current of 35-50kA and an electron density of 2-4 x 10 to the 12th/cu cm to study the interaction between them. The current-driven plasmas show no disruption at the pellet injection, whereas all of the ohmic discharges are disruptive. These phenomena are interrupted briefly with results of a sudden decrease of the electron temperature and density rises of 6-8 x 10 to the 12th/cu cm for the iron pellet and 4 x 10 to the 12th/cu cm for the carbon pellet. The electron temperature after the injection is estimated to be about 10 eV from the density rise and the calculation of the impurity charge states. The decaying time of the injected impurity is measured to be 25ms from the time behavior of the soft X-ray emission. Author

**N89-18196#** Nagoya Univ. (Japan). Inst. of Plasma Physics.
**THE 10 CHANNEL GRATING POLYCHROMATOR FOR THE MEASUREMENTS OF ELECTRON CYCLOTRON EMISSION**
Kazuo Kawahata, Kiyomi Sakai, Ritoku Ando, Sinji Ohara, and Junji Fujita Nov. 1988 33 p
(IPPJ-893; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

A 10-channel grating polychromator has been developed and applied for the measurements of the second harmonic electron cyclotron emission from the JIPP T-IU tokamak plasma. The frequency resolution measured at 150 GHZ is about 3 GHz which corresponds to the spatial resolution of 1.8 cm near the center of the plasma column. The grating efficiency is about 80 pct for S-polarization around 160 GHz. Its excellent time resolution, delta t less than or equal to 2 microsecond is favorable for studying MHD activities in hot plasmas. It has been found from the measurements in JIPP T-IU that the grating polychromator is a powerful diagnostic tool for the measurement of the electron temperature of the plasma. Author

**N89-18197#** Oak Ridge National Lab., TN. Fusion Engineering Design Center.
**THE CONFIGURATION DEVELOPMENT OF THE COMPACT IGNITION TOKAMAK DEVICE**
T. G. Brown 1988 22 p Presented at the 12th Symposium on Fusion Engineering, Monterey, CA, 12 Oct. 1987
(Contract DE-AC05-84OR-21400)
(DE88-015229; CONF-871007-71) Avail: NTIS HC A03/MF A01

The Compact Ignition Tokamak (CIT) device is planned as the next major fusion device to be built at the Princeton Plasma Physics Laboratory to demonstrate ignition operations of a burning plasma. Stringent engineering requirements have been imposed on this device by physics necessities of high margins against ignition and by cost constraints in minimizing the overall cost of the project. A compact design has been developed under these design conditions incorporating many unique design features, including a hydraulic preload system to provide a compression load to the toroidal field (TF) inner leg and using a high-strength copper-Inconel composite material in the design of the TF coil and the ohmic heating solenoid. The device is inertially cooled by liquid nitrogen, and the vacuum vessel, coils, and supporting structure are contained in a thermally insulated cryostat. A close-in igloo shield surrounds the device to provide the capability for hands-on access within the test cell and also to minimize activation. Even with the compact nature of this device, there still remains the basic requirement of maximizing access to the plasma for diagnostics and heating components; access for electrical leads and coolant lines; and access to provide the capability of remotely maintaining all diagnostic and peripheral equipment that interfaces with the device. This paper describes the configurational development that has taken place during the conceptual design period of the CIT project, highlighting the major design integration features used to develop a functional device that meets the physics and component design requirements. DOE

**N89-18198#** Los Alamos National Lab., NM.
**A TRAVELING WAVE APPROACH TO PLASMA PUMPING FOR X-RAY SOURCES**
Reed J. Jensen 1988 13 p Presented at the U S/Japan Seminar, Honolulu, HI, 7 Aug. 1988
(Contract W-7405-eng-36)
(DE89-002040; LA-UR-88-3347; CONF-8808169-1) Avail: NTIS HC A03/MF A01

Optical angular multiplexing allows the extraction of multiple short pulses from a single long pulse amplifier. In the Inertial Confinement Fusion (ICF) case a single short pulse is divided into many short pulses of the same temporal profile using beam splitters. The pulses are routed through the amplifier system at slightly different angles and then are played onto a small target simultaneously to produce higher instantaneous power. In the proposed scheme the pulses can be arranged to provide traveling waver excitation to facilitate amplification of spontaneous emission. DOE

# 76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

**N89-18199#** Naval Research Lab., Washington, DC.
**THE EFFECT OF ENERGETIC CHARGED PARTICLE BOMBARDMENT ON THE PROPERTIES OF THIN FILMS OF HIGH T(SUB c) SUPERCONDUCTORS Final Technical Report**
Douglas B. Chrisey 1 Oct. 1988 30 p
(AD-A199883) Avail: NTIS HC A03/MF A01 CSCL 20C

The effects of low fluence (less than 10 to the 14th power sq cm) 63 MeV H(+) and 65 MeV He2(+) irradiation of prototype thin films of YBa2Cu3O(7 - delta) produced by a plasma arc spray technique are discussed. The observed change in the resistance versus temperature behavior is much more dramatic than that observed for films produced by other techniques and resembles qualitatively a bond percolation threshold. The radiation sensitivity of these plasma-arc spray films is concluded to be due to poor intergranular characteristics. This information is being used to modify the processing steps to improve the properties of films produced by this technique. In contrast, high energy H and He ion irradiation of the laser evaporated films resulted in a negligible change in the resistance-temperature behavior. The low energy B and N ion irradiation of the laser evaporated films had the effect of a gradual lowering of the completion temperature of the superconducting transition (T sub c - completion). The gradual lowering of T sub c - completion with fluence, d (delta T sub c)/d phi, with similar results by other groups. This behavior is interpreted as a progressive decoupling of the grains and extrinsic to that of the bulk YBa2Cu3O(7-delta). GRA

**N89-18200#** Stanford Linear Accelerator Center, CA. Dept. of Applied Physics.
**IN SITU GROWTH OF SUPERCONDUCTING YBaCuO USING REACTIVE ELECTRON-BEAM COEVAPORATION**
N. Missert, R. Hammond, J. E. Mooij, V. Matijasevic, P. Rosenthal, T. H. Geballe, A. Kapitulnik, M. R. Beasley, S. S. Laderman, and C. Lu Sep. 1988 5 p Presented at the Applied Superconductivity Conference, San Francisco, CA, 21 Aug. 1988 Prepared in cooperation with Hewlett-Packard Co., XINIX, Inc.; and Conductus, Inc.
(Contract DE-AC03-76SF-00515)
(DE89-002071; SU-SLAC-PUB-4698; CONF-880812-20) Avail: NTIS HC A02/MF A01

Conditions required for in situ growth of YBaCuO thin films by reactive electron-beam evaporation have been explored. Three sources of activated oxygen (atomic oxygen from microwave discharge, a plasma generated by electron beams, and an ion beam) were compared. The best results so far were obtained with atomic oxygen. Epitaxial films with high critical currents were grown on SrTiO3, Al2O3, and MgO at 600 C. Evaporation rates were controlled with a rate monitor using atomic absorption. DOE

**N89-18201*#** Massachusetts Inst. of Tech., Cambridge. Dept. of Materials Science and Engineering.
**CRYSTAL GROWTH OF DEVICE QUALITY GaAs IN SPACE Final Report, 1 Dec. 1985 - 30 Nov. 1988**
Harry C. Gatos and Jacek Lagowski Feb. 1989 32 p
(Grant NsG-7331)
(NASA-CR-184793; NAS 1.26:184793) Avail: NTIS HC A03/MF A01 CSCL 20L

The program on Crystal Growth of Device Quality GaAs in Space was initiated in 1977. The initial stage covering 1977 to 1984 was devoted strictly to ground-based research. By 1985 the program had evolved into its next logical stage aimed at space growth experiments; however, since the Challenger disaster, the program has been maintained as a ground-based program awaiting activation of experimentation in space. The overall prgram has produced some 80 original scientific publications on GaAs crystal growth, crystal characterization, and new approaches to space processing. Publication completed in the last three years are listed. Their key results are outlined and discussed in the twelve publications included as part of the report. Author

**N89-18202#** Argonne National Lab., Idaho Falls, ID. Energy and Environmental Systems Div.
**POTENTIAL BENEFITS OF SUPERCONDUCTIVITY TO TRANSPORTATION IN THE UNITED STATES**
Donald M. Rote and Larry R. Johnson 1988 7 p Presented at the First International Symposium on Superconductivity, Nagoya, Japan, 29 Aug. 1988 Sponsored in part by EPRI
(Contract W-31-109-eng-38)
(DE89-003957; CONF-880842-1) Avail: NTIS HC A02/MF A01

Research in U.S. transportation applications of superconductors is strongly motivated by a number of potential national benefits. These include the reduction of dependence on petroleum-based fuels, energy savings, substantially reduced air and noise pollution, increased customer convenience, and reduced maintenance costs. Current transportation technology offers little flexibility to switch to alternative fuels, and efforts to achieve the other benefits are confounded by growing congestion at airports and on urban roadways. A program has been undertaken to identify possible applications of the emerging superconducting applications to transportation and to evaluate potential national benefits. The current phase of the program will select the most promising applications for a more detailed subsequent study. Transportation modes being examined include highway and industrial vehicles, as well as rail, sea, air transport and pipelines. Three strategies are being considered: (1) replacing present components with those employing superconductors, (2) substituting new combinations of components or systems for present systems, and (3) developing completely new technologies. Distinctions are made between low-, medium-, and near-room-temperature superconductors. The most promising applications include magnetically levitated passenger and freight vehicles; replacement of drive systems in locomotives, self-propelled rail cars, and ships; and electric vehicles inductively coupled to electrified roadways. DOE

**N89-18203#** Sandia National Labs., Albuquerque, NM.
**HYDROGEN ION BEAM SMOOTHENING OF OXYGEN ROUGHENED Ge(001) SURFACES**
K. M. Horn, Eric Chason, J. Y. Tsao, and S. T. Picraux 1988 6 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 28 Nov. 1988
(Contract DE-AC04-76DP-00789)
(DE89-004375; SAND-88-1655C; CONF-881155-17) Avail: NTIS HC A02/MF A01

A smooth Ge(001) surface can be severely roughened by chemical etching with oxygen gas and then returned to its original smoothness by exposure to hydrogen. The rate of recovery of the surface depends strongly on temperature, as well as on whether the hydrogen is introduced as a low energy ion beam or simply as a gas. The roughness induced in the surface by etching is locked-in after removal of the oxygen gas through pinning of ledges by residual contamination. This pinning prevents the surface from smoothening thermally. The introduction of hydrogen to the surface promotes a chemical reaction which frees the pinned sites and allows thermal smoothening to proceed. DOE

**N89-18204#** Sandia National Labs., Albuquerque, NM.
**DISLOCATIONS AND BUBBLES IN BF2(+) IMPLANTED SILICON**
G. E. Pike, M. J. Carr, W. K. Schubert, C. R. Hills, G. C. Nelson, and P. J. McWhorter 1988 6 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 28 Nov. 1988
(Contract DE-AC04-76DP-00789)
(DE89-004582; SAND-88-1677C; CONF-881155-22) Avail: NTIS HC A02/MF A01

Defects in crystalline silicon caused by a BF (+) sub 2 ion implantation dose of 3 times 10 to the 15th power cm (-2) have been studied using plan-view and cross-section TEM and SIMS. Dislocations form at annealing temperatures above 1000 C and are pinned below the Si surface by fluorine bubbles approximately 10 nm diameter at a density of approximately 10 to the 11th power cm (-2). This microstructure is essentially stable at 1150 C from 4 to 400 minutes. DOE

**N89-18205#** Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Physik.
**SPECIFIC HEAT AND ENTROPY OF HEAVY FERMION SYSTEMS, AND THE INTERACTION BETWEEN KONDO AND CRYSTAL FIELD EFFECT Ph.D. Thesis [SPEZIFISCHE WAERME UND ENTROPIE VON SCHWERE-FERMIONEN-SYSTEMEN UND DIE WECHSELWIRKUNG ZWISCHEN KONDO- UND KRISTALLFELD-EFFEKT]**
Rainer Felten 1987 172 p In GERMAN
(ETN-89-93509) Avail: NTIS HC A08/MF A01

The superconductors CeCu2Si2, UBe13 and UPt3, the nonmagnetic systems CeAl3 and CeCu6, and the magnetically ordered systems CeAl2, CeCu2Ge2, CeRu2.16Ge2, and CeAu2Ge2 were investigated in order to improve the understanding of the physics of heavy Fermion systems. The theoretical fundamentals of crystal field and Kondo anomaly, and the specific heat measuring method are presented. The measurements of the specific heat in the temperature range between 3 and 350K show that all the investigated systems have a crystal field splitting of the ground state multiplet; the splitting can be determined from the measured anomalies. The experimental observations are consistent with the existing theoretical calculations concerning the interaction between Kondo and crystal field effect. The Kondo effect lowers and broadens the crystal field anomaly, if the splitting is not large compared with the Kondo temperature. ESA

**N89-18206#** International Centre for Theoretical Physics, Trieste (Italy).
**SELF-SIMILARITY CORRELATIONS IN HIGH-TEMPERATURE SUPERCONDUCTIVITY**
Z. Arvay Aug. 1988 6 p
(DE88-704720; IC-88/167) Avail: NTIS (US Sales Only) HC A02/MF A01

Thermally induced structural phase transitions produce self-similar quasi-2D chain-like structure in the CuO2 planes. Self-similar, scale invariant wave functions-solutions of the scale invariant Hamiltonian-represent states of long range correlations. These intrinsically correlated states can be observed as carriers of super-current. The conformal invariant string theory is proposed as a first approximation to describe the mechanism of high-temperature superconductivity. DOE

**N89-18207#** International Centre for Theoretical Physics, Trieste (Italy).
**CORRELATION BETWEEN ELECTRONEGATIVITY AND SUPERCONDUCTIVITY**
R. Asokamani and R. Manjula Aug. 1988 18 p
(DE88-704727; IC-88/177) Avail: NTIS (US Sales Only) HC A03/MF A01

This paper brings out one of the striking features exhibited by all oxide superconductors. It is found that irrespective of the values of T sub c, the average electronegativity, x of all the oxide superconductors lies between 2.5 and 2.65. This is in contrast to the elemental superconductors whose x values lie in a broad range from 1.3 to 1.9. Further, the pressures required to drive some of the elemental metals to become superconductors have been calculated on the basis of their electronegativity values. The pressures so obtained agree very well with the experimental observations and those calculated on the basis of band theory. The average electronegativity of A-15 and Cheverel phase superconductors are also given. Based on the concept of electronegativity the other oxide systems which are likely to become superconductors have been suggested. DOE

**N89-18208#** International Centre for Theoretical Physics, Trieste (Italy).
**NEW EFFECT ON THE DEPENDENCE OF T(SUB c) ON THE NUMBER OF Cu-O LAYERS IN THE NON-RARE-EARTH CERAMIC SUPERCONDUCTORS**
J. Chela-Flores, P. Martin, and J. J. Rodriguez-Nunez Aug. 1988 14 p
(DE88-704735; IC-88/201) Avail: NTIS (US Sales Only) HC A03/MF A01

It is argued from the experimental evidence that the superconductivity in the non-rare-earth compounds is confined to two inequivalent layers of Cu-O planes where electron pairing occurs. This conjecture leads to a set of phenomenological equations in terms of two order parameters that correctly describe the characteristic lengths of the copper oxide ceramics. The formalism developed indicates that samples with a larger number of Cu-O layers may have higher transition temperatures. The formalism suggests that in a multilayered Cu-O compound increments of T sub c as a function of the doping parameter will be more pronounced the larger the number of layers. DOE

**N89-18209#** International Centre for Theoretical Physics, Trieste (Italy).
**ELECTRONIC STRUCTURE OF VH, NbH AND TaH IN THE BETA-PHASE**
Patricia Vargas Aug. 1988 8 p
(DE88-704736; IC-88/202) Avail: NTIS (US Sales Only) HC A02/MF A01

Calculations of the DOS (Density of States) for the three mono-hydrides of V nB and Ta in the orthorhombic Beta -phase were performed using the LMTO method. In all three systems the hydrogen induced states below the Fermi level split in two maxima as a consequence of the H-H interactions. This fact agrees with photo-emission experiments. We report also the calculated Bulk Modulus and equilibrium lattice parameters. This is the first time that a hand structure calculation is reported for the Beta -VH and Beta -TaH systems. DOE

**N89-18210#** International Centre for Theoretical Physics, Trieste (Italy).
**DEFORMATION POTENTIALS OF SOME 2-6 SEMICONDUCTORS AT K=O STATES**
J. L. Galan, A. Camacho, and L. Quiroga Aug. 1988 9 p
(DE88-704743; IC-88/220) Avail: NTIS (US Sales Only) HC A02/MF A01

Presented is a tight-binding calculation of the deformation potentials for three 2 to 6 compounds: CdTe, ZnTe and HgTe by very simple strain modifications of nondiagonal tight-binding parameters, which are compared with experimental values. The agreement is good for both kinds of deformation potentials: the hydrostatic one which depends on the nondiagonal matrix elements and the uniaxial one which is mainly a measure of the diagonal interactions and thus depend directly on the tight-binding parameters used. DOE

**N89-18211#** International Centre for Theoretical Physics, Trieste (Italy).
**EFFECT OF RVB FLUX CONFIGURATION ON THE SUPERCONDUCTING STATE**
G. Baskaran, E. Tosatti, and Yu Lu Aug. 1988 12 p
(DE88-704747; IC-88/230) Avail: NTIS (US Sales Only) HC A03/MF A01

The Resonating Valance Bond (RVB) state is a singlet quantum liquid which can support periodic or fluid-like quantum circulation around the elementary plaquette in two dimensions. In the s+id phase there is a half flux quanta of circulation in every elementary plaquette. We show that the holons in the presence of this lattice of circulation have a two-valley structure, as opposed to s or d states, which have a single valley. Using an effective holon Hamiltonian, we study the mean-field properties of the two-valley holon condensate, and compare its energy with the single valley case. A transition from the d to the s+id state is predicted with increasing hole concentration for sufficiently large Hubbard U. Some speculations are offered about the general case of a fluid-like distribution of flux quanta. DOE

**N89-18212#** International Centre for Theoretical Physics, Trieste (Italy).
**PREPARATION DEPENDENT SUPERCONDUCTIVITY IN TlCaBa2Cu3O7.5(SUB+-)D ABOVE 100K**
T. Porjesz, I. Halasz, T. Traeger, G. Kovacs, I. Kirschner, G. Zsolt, and T. Karman Aug. 1988 12 p Submitted for publication
(DE88-704751; IC-88/244) Avail: NTIS (US Sales Only) HC A03/MF A01

Different heat treatment procedures were applied during the sample preparation process, which result in different superconducting properties in the samples of the same nominal composition of TlCaBa sub 2 Cu sub 3 O sub 7.5 plus or minus d. It manifests itself in the different critical temperatures having values of 104 K, 107 K and 93 K. The effect of heat treatments is reflected in the structural and magnetic properties as well. DOE

**N89-18213#** International Centre for Theoretical Physics, Trieste (Italy).
**HIGH-T(SUBc) SUPERCONDUCTIVITY OF Tl-Ba-Ca-Cu-O SAMPLES**
T. Porjesz, I. Kirschner, and G. Kovacs Aug. 1988 13 p
(DE88-704755; IC-88/251) Avail: NTIS (US Sales Only) HC A03/MF A01

A TlBaCaCuO(sub 4.5+x) compound has been investigated from the point of view of superconductivity. Depending on the heat treatment, one part of the sample exhibits superconductivity with an onset of 121 K and zero resistivity of 106 K and the other part of them shows a sharp drop in resistivity at 130 K which hints at an existence of superconducting grains. This picture

was confirmed by magnetic and ESR measurements giving possibility for estimation of critical magnetic fields. DOE

**N89-18214#** International Centre for Theoretical Physics, Trieste (Italy).
**BOND PARTICLE MODEL FOR SEMICONDUCTOR MELTS AND ITS APPLICATION TO LIQUID STRUCTURE GERMANIUM**
A. Ferrante (International School for Advanced Studies, Trieste, Italy ) and M. P. Tosi Aug. 1988 34 p
(DE88-704759; IC-88/256) Avail: NTIS (US Sales Only) HC A03/MF A01

A simple type of liquid state model is proposed to describe on a primitive level the melt of an elemental group 4 semiconductor as a mixture of atoms and bond particles. The latter, on increase of a coupling strength parameter becomes increasingly localized between pairs of atoms up to local tetrahedral coordination of atoms by bond particles. Angular interatomic correlations are built into the model as bond particle localization grows, even though the bare interactions between the components of the liquid are formally described solely in terms of central pair potentials. The model is solved for liquid structure by standard integral equation techniques of liquid state theory and by Monte Carlo simulation, for values of the parameters which are appropriate to liquid germanium down to strongly supercooled states. The calculated liquid structure is compared with the results of diffraction experiments on liquid germanium near freezing and discussed in relation to diffraction data on amorphous germanium. The model suggests simple melting criteria for elemental and polar semiconductors, which are empirically verified. DOE

**N89-18215#** International Centre for Theoretical Physics, Trieste (Italy).
**VORTEX STRUCTURE IN HIGH-T(SUBc) CERAMIC SUPERCONDUCTORS**
A. G. Saif and J. Chela-Flores Aug. 1988 12 p
(DE88-704766; IC-88/276) Avail: NTIS (US Sales Only) HC A03/MF A01

We consider penetration of magnetic flux in the rare earth ceramic superconductors within the framework of a generalized Ginzburg-Landau theory, based on the coexistence of antiferromagnetism and superconductivity. We study vortex structure produced for a magnetic field close to H sub c(sub 1). We make a new prediction that may serve to test the theory experimentally. DOE

**N89-18216#** International Centre for Theoretical Physics, Trieste (Italy).
**MERCEREAU EFFECT AS A GUIDE TO THE THEORY OF HIGH-T(SUB c) SUPERCONDUCTIVITY IN RARE EARTH OXIDE CERAMICS**
J. Chela-Flores, P. Martin, and J. J. Rodriguez-Nunez Aug. 1988 17 p
(DE88-704767; IC-88/277) Avail: NTIS (US Sales Only) HC A03/MF A01

We emphasize the importance of performing definite experiments on quantum interferometers, basing our work on a phenomenological theory of high-T sub c superconductivity co-existing with antiferromagnetism. The theory satisfies all the general requirements of previous models, including minimal gauge invariant coupling terms. Yet, since no doping-dependent displacements are implied in the Mercereau diffraction pattern, this phenomenological approach underlines the urgency of performing new experiments in order to guide the theory. DOE

**N89-18217#** Gosudarstvennyj Komitet po Ispolzovaniyu Atomnoi Energii, Serpukhov (USSR).
**ON-LINE SYSTEM FOR MEASURING ELECTROPHYSICAL CHARACTERISTICS OF SUPERCONDUCTING WIRES**
A. G. Aleksandrov, M. G. Vybornov, and A. G. Goremykin 1987 13 p In RUSSIAN; In RUSSIAN
(DE88-704770; IFVE-OEA-87-197) Avail: NTIS (US Sales Only) HC A03/MF A01

A system for measuring electrophysical characteristics of superconducting wires, containing a set of SUMMA modules controlled by the Elektronika-60 microcomputer is described. The system is intended for measuring magnetization, dynamic losses and critical current density in superconducting wires. The system structure, measurement methods and algorithm, and the results obtained are presented. DOE

**N89-18218#** Midwest Research Inst., Golden, CO. Solar Energy Research Inst.
**NOVEL SILANE AND DISILANE PRECURSORS TO AMORPHOUS SEMICONDUCTORS Final Subcontract Report, May 1988**
U. C. Pernisz and K. G. Sharp Sep. 1988 63 p Prepared in cooperation with Dow Corning Corp., Midland, MI.
(Contract DE-AC02-83CH-10093)
(DE89-000825; SERI/STR-211-3415) Avail: NTIS HC A04/MF A01

This final report describes the preparation and characterization of amorphous fluorohydrogenated silicon thin films. The novel approach in this study lies in the use of fluorinated silanes as film precursors. The advantages of this method are well defined initial ratios of hydrogen and fluorine to silicon and greatly reduced hazards in the handling of the gas. Fluorine derivatives of both silane and disilane were synthesized. Both glow discharge (or plasma-enhanced CVD) and thermal (CVD) methods were employed to prepare amorphous silicon on glass and silicon wafers. The electrical characterization of the material prepared from difluorosilane showed that the a-Si:H:F films obtained are of solar-grade semiconductor quality and can be doped to p- and n-type materials with diborane and phosphine. DOE

**N89-18219#** Lawrence Livermore National Lab., CA.
**SUPPRESSION OF DEFECT PROPAGATION IN HETEROEPITAXIAL STRUCTURES BY STRAINED LAYER SUPERLATTICES**
Z. Liliental-Weber, E. R. Weber, J. Washburn, T. Y. Liu, and H. Kroemer May 1988 10 p Presented at the NATO Advanced Study Institute Workshop - Heterostructures on Si: One Step Further With Silicon, Cargese, France, 15 May 1988
(Contract DE-AC03-76SF-00098)
(DE89-002955; LBL-25780; CONF-8805222-1) Avail: NTIS HC A02/MF A01

Defects present in GaAs on Si(211) heteroepitaxial layers grown by MBE have been analyzed in detail by Transmission Electron Microscopy (TEM). Efficient reduction of dislocation propagation by strained layer superlattices was found. The mechanisms of defect reduction were suggested based on Burgers vector analysis. It was shown that additional threading dislocations can glide into the epilayer during cooling process and that misfit dislocations at the interface can be forced to dissociate on a 111 plane inclined to the interface leaving one partial dislocation at the interface and forming extended stacking faults. DOE

**N89-18220#** Argonne National Lab., IL. Materials and Components Technology Div.
**ADVANTAGES OF HIGH-TEMPERATURE SUPERCONDUCTIVITY IN LARGE-SCALE APPLICATIONS**
John R. Hull and Greg F. Berry 1988 25 p Presented at the ASME Winter Annual Meeting, Chicago, IL, 28 Nov. 1988
(Contract W-31-109-eng-38)
(DE89-003662; CONF-881120-19) Avail: NTIS HC A03/MF A01

The discovery of superconducting materials with critical temperatures above the boiling point of nitrogen is expected to lead to increased viability of many existing large-scale applications of superconductivity and to the enabling of many new applications. Whereas the readily available terrestrial supply of liquid helium is insufficient for widespread use of superconductivity, the supply of nitrogen is ample. Operation at liquid nitrogen temperatures improves the refrigeration factor by about 25, allowing smaller sized devices to be feasible. The larger heat capacity improves stability of operation. DOE

**N89-18221#** Argonne National Lab., IL. Materials Science Div.
**ROLE OF THE DENSEST LATTICE PLANES IN THE STABILITY OF CRYSTALLINE INTERFACES: A COMPUTER SIMULATION STUDY**
D. Wolf and S. Phillpot Jun. 1988 40 p Presented at the Symposium on Interfacial Phenomena in Composites, Newport, RI, 1 Jun. 1988
(Contract W-31-109-eng-38)
(DE89-003666; CONF-8806155-3) Avail: NTIS HC A03/MF A01

The zero-temperature energies and equilibrium volume expansions of point-defect free grain boundaries (GBs) on the two densest planes of fcc copper, bcc molybdenum and cubic-diamond silicon have been determined, using an Embedded-Atom-Method potential for Cu, a Finnis-Sinclair potential for Mo, and the Stillinger-Weber potential for Si. It is found that in all three structures the energies of the GBs on the second-densest planes are about two to three times higher than of those on the densest planes. For the metals a strong correlation between GB energy and volume expansion at the GB is observed. Owing to its covalent nature of binding such a correlation is not found for Si. It is illustrated that atoms in very close contact (up to about 10 percent closer than the perfect-crystal nearest-neighbor distance) are mainly responsible for the very large anisotropy in the GB energy. Since the strong repulsive forces between such atoms should be active even in complex interface systems (such as meal-ceramic interfaces or strained-layer superlattices), we suggest that the energetics of even more general interfaces is strongly influenced by Pauli's principle. DOE

**N89-18222#** Massachusetts Inst. of Tech., Cambridge. National Magnet Lab.
**BASIC STUDIES OF SUBMICRON LAYERS OF Nb-Al Final Report**
1988 7 p
(Contract DE-FG02-85ER-45206)
(DE89-003817; DOE/ER-45206/5) Avail: NTIS HC A02/MF A01

Recent work with powder metallurgy processed Nb-Al has shown that thin layers of extruded Nb and Al reacted at low temperatures can form superconducting Nb-Al with high superconducting transition temperatures well above that expected from the equilibrium phase diagram for Nb-Al with high critical current densities. The basic mechanisms for the low temperature reaction and the importance of surface effects, impurities, and the dependence of layer thickness in Nb-Al have not been explored. The purpose of the research program was a basic study of model layered structures of Nb and Al in order to develop an understanding of the basic properties of low temperature reactions at the Nb/Al interface. The research employed bilayers and multilayers of Nb and Al. DOE

**N89-18223#** Argonne National Lab., IL.
**HIGH-FLUENCE NEUTRON IRRADIATION OF SUPERCONDUCTING NbN FILMS**
H. W. Weber, P. Gregshammer, R. T. Kampwirth, and K. E. Gray 1988 14 p Presented at the MRS International Meeting on Advanced Materials, Tokyo, Japan, 30 May 1988
(Contract W-31-109-eng-38)
(DE89-004209; CONF-880529-7) Avail: NTIS HC A03/MF A01

A variety of sputtered NbN films have been irradiated with reactor neutrons at ambient temperature up to a total fluence of 10 to the 23/m (E greater than 0.1 MeV). Only small decreases of T sub c (4 to 7 percent) and moderate increases of rho sub n (approx. 25 percent) are observed. Both of these quantities are difficult to interpret because of the granular nature of the films. The critical current densities have been determined in most cases for magnetic fields up to 20 T. While some degradation (approx. 30 percent) of j sub c occurs in the intermediate field range (6 to 15 T), the high field data show no change of j sub c or even small increases due to the radiation-induced increase of H sub c2 and the occurrence of peak effects near H sub c2. The present experiments demonstrate unambiguously that NbN is an extremely radiation-hard high-field superconductor. DOE

**N89-18224#** Brookhaven National Lab., Upton, NY.
**THE EFFECT OF SELF FIELD ON THE CRITICAL CURRENT DETERMINATION OF MULTIFILAMENTARY SUPERCONDUCTORS**
M. Garber, A. K. Ghosh, and W. B. Sampson 1988 6 p Presented at the Applied Superconductivity Conference, San Francisco, CA, 21 Aug. 1988
(Contract DE-AC02-76CH-00016)
(DE89-004527; BNL-41977; CONF-880812-31) Avail: NTIS HC A02/MF A01

In determining the short sample critical current of conductors of large cross section or high current density the self field produced by the transport current must be taken account in order to obtain a true value for the critical current. A simple model calculation for determining this effect is described. Measurements on wires, cables, and monoliths show the validity and self consistency of the procedures. DOE

**N89-18225#** Brookhaven National Lab., Upton, NY.
**NORMAL STATE RESISTANCE AND LOW TEMPERATURE MAGNETORESISTANCE OF SUPERCONDUCTING CABLES FOR ACCELERATOR MAGNETS**
W. B. Sampson, M. Garber, and A. K. Ghosh 1988 4 p Presented at the Applied Superconductivity Conference, San Francisco, CA, 21 Aug. 1988
(Contract DE-AC02-76CH-00016)
(DE89-004528; BNL-41976; CONF-880812-30) Avail: NTIS HC A02/MF A01

The normal state resistivity of the superconducting NbTi cable used in accelerator magnets is usually specified by the resistance per unit length at room temperature (295 K) and the Residual Resistance Ratio (RRR). Using these resistance parameters, the amount of copper in the multifilamentary wire can be calculated. This method is consistent with the traditional etch and weigh technique, and as such is a alternative and convenient way of specifying the copper to superconductor ratio. Measurements of magnetoresistance for a wide variety of SSC inner cables show considerable disagreement with calculation. In this paper the magnetoresistance data on cables with RRR ranging from 50 to 175 are analyzed taking into account the conductor geometry and the effect of the small interfilamentary spacing on the resistivity of copper. DOE

**N89-18226#** University of Southern California, Los Angeles. Dept. of Chemical Engineering.
**CRITICAL BEHAVIOR OF TRANSPORT AND MECHANICAL PROPERTIES IN PARTICULATE DISPERSIONS AND GRANULAR MEDIA Final Report, 1 Jun. 1987 - 31 May 1988**
J. D. Goddard, J. P. Bardet, C. Campbell, and M. Sahimi 29 Jul. 1988 42 p
(Grant AF-AFOSR-0284-87; AF Proj. 2302)
(AD-A200698; AFOSR-88-1155TR) Avail: NTIS HC A03/MF A01 CSCL 20L

This is a final report on research performed, under AFOSR Grant-87-0284 for the period 1 June 1987 to 31 May 1988, on microstructural dynamics of particulate and granular media. Methods of statistical physics have been applied to the interpretation of computer simulations of the mechanical and transport properties granular materials and disordered solids. A new continuum theory of Reynolds dilatancy in granular masses has been developed and a mechanical test facility has been developed under joint funding from the National Science Foundation. GRA

**N89-18227#** Auburn Univ., AL. Dept. of Chemical Engineering.
**INVESTIGATION OF COUPLED SURFACE AND BULK REACTION PHENOMENA USING COMBINED-BACKSCATTER-CONVERSION ELECTRON AND BACKSCATTER-PHOTON MOSSBAUER SPECTROSCOPY (CEAPS) Final Report, 1 Sep. 1984 - 30 Apr. 1988**

Bruce J. Tatarchuk 30 Aug. 1988 15 p
(Grant AF-AFOSR-0301-84; AF Proj. 2303)
(AD-A200730; AFOSR-88-1114TR) Avail: NTIS HC A03/MF A01 CSCL 20E

A combined-backscatter-conversion electron and back-scatter-photon Mossbauer spectrometer has been constructed and used in conjunction with new theoretical modeling efforts to examine a number of thin-film system. The spectrometer permits nondestructive depth-profiling from the topmost monolayer to as deep as 20 microns into the bulk and is ideal for examining the chemistry which occurs at buried-interfaces. Systems investigated include: (1) iron overlayers on MoS2, (2) FeTi-hydrides, (3) Pd-coated FeTi-hydrides, (4) ion-mixed FeSn interfaces, and (5) atomic oxygen protective coatings on iron containing substrates. Results of these studies provide: (1) adhesion, reaction and intercalation mechanisms of MoS2 on iron substrates, (2) deactivation mechanisms for FeTi materials, (3) protection of FeTi materials by Pd-overlayers, (4) phase behavior, depth and compounds formed after ion beam mixing FeSn interfaces, and (5) oxidation rates for FeAg substrates below SiO2 overlayers exposed to atomic oxygen. GRA

**N89-18228#** Kansas State Univ., Manhattan. Dept. of Chemistry.
**NATURE OF CHEMISORBED SPECIES ON METAL OXIDE SURFACES. ELECTRON TRANSFER AND BOND-BREAKING PROCESSES**
I. Nieves and K. J. Klabunde 1988 15 p
(AD-A200736; ARO-24939.5-CH) Avail: NTIS HC A03/MF A01 CSCL 07B

Highly ionic insulator oxides, in particular magnesium oxide, can be prepared in high surface area form possessing many surface defect sites. The nature of these thermally robust defects are either structural (edges, planes, kinks, cation and anion vacancies) or electronic (electron excess or deficient sites). Extremely basic, electron rich sites are capable of strongly interacting with chemisorbing molecules. Proton abstraction, electron transfer, molecular oligomerization, base condensation, and radical trapping reactions have been observed with various adsorbing organic molecules. Adsorbed species can be readily detected with appropriate spectroscopic tools. Further technological use of thermally activated MgO and other oxides appear promising, especially in such areas as selective hydrocarbon H-D exchange catalysts, and destructive adsorbants for air purification purposes. GRA

**N89-18229#** Defence Research Analysis Establishment, Ottawa (Ontario).
**THE EFFECTS OF GATE BIAS AND HYDROGEN ATMOSPHERE ON THE RADIATION RESPONSE OF THE MOSFET**
S. McGowan Mar. 1988 23 p
(AD-A200791; DREO-TN-88-21) Avail: NTIS HC A03/MF A01 CSCL 09A

Ionizing radiation produces hole-electron pairs in the oxide layers of metal-oxide-semiconductor (MOS) structures, generally resulting in a permanent or semi-permanent positive charge being trapped in the oxide. In the absence of a large electric field, recombination reduces the charge separation but net positive charge density results from the high diffusivity of the electrons relative to the holes and from the predominance of hole traps in the oxide, particularly near the Silicon/Silicon dioxide interface of silicon-based devices. The presence of an electric field during irradiation facilitates separation of the holes and electrons, thus reducing recombination and redistributing (or removing) the charge. The sensitivity of Metal Oxide Semiconductor Field Effect Transistor, (MOSFET) radiation sensors has been measured as a function of gate-to-source bias. The observed sensitivity-bias relation can be explained in terms of hole/electron recombination, charge trapping and charge transport in the oxide. To explain post-irradiation increases in the MOSFET readings, negative-charge trapping and detrapping in the oxide is proposed. The sensitivity of these MOSFETs has been found to be affected by the presence of hydrogen, indicating that hydrogen alters the trapping properties of the oxide. It may be possible to control the sensitivity of these sensors by controlling the hydrogen concentration at the time of hermetic packaging. GRA

**N89-18230#** Wisconsin Univ., Milwaukee. Dept. of Physics.
**BULK WAVE CHARACTERIZATION OF HIGH T(SUB c) SUPERCONDUCTORS Annual Summary Report, 1 Aug. - 1 Nov. 1988**
Moises Levy and Bimal Sarma 1 Nov. 1988 11 p
(Contract N00014-88-K-0046)
(AD-A200795) Avail: NTIS HC A03/MF A01 CSCL 07B

The objective of this research is to characterize high T(sub c) superconductors with longitudinal and transverse ultrasonic waves. Both attenuation and velocity measurements have been performed on sinter forged samples of YBa2Cu3O7, which has two CuO planes perpendicular to the c-axis per unit cell. Three elastic constants, C11, C33 and C44, out of five, for this axially symmetric sample, with 80 percent of the c-axis of platelet like crystallites aligned along the forging axis, have been determined. Three maxima in attenuation are observed at 70 K, 180 K, and 250 K when longitudinal waves are propagated perpendicular to the forging axis. Only the middle maximum is observed when either longitudinal or transverse waves propagate parallel to the forging axis or perpendicular to CuO planes. Thus, the middle maximum may be due to an isotropic interaction while the other maxima may be produced by interactions associated with distortions of the CuO planes. Frequency dependent measurements on sintered samples of YBa2Cu3O7 show that the low temperature maximum is produced by a relaxation mechanism. The activation energy of the relaxation time for this maximum is about 400 K which is near the Debye temperature of this compound. Sound measurements in a sample of Ba0.625K0.375BiO3, which has a T(sub c) = 28 K and which is postulated to be a BCS superconductor, show a maximum in attenuation around 50 K. GRA

**N89-18231#** Cornell Univ., Ithaca, NY. Dept. of Electrical Engineering.
**A STUDY OF Ga(0.47)In(0.53)As/Al(0.48)In 0.52)As FOR VERY HIGH FREQUENCY DEVICE APPLICATIONS Final Report, 1 Sep. 1985 - 31 May 1988**
Lester F. Eastman and L. F. Palmateer 10 Oct. 1988 13 p
(Contract DAAG29-85-K-0213)
(AD-A200925; ARO-22593.3-EL) Avail: NTIS HC A02/MF A01 CSCL 20L

AlInAs/GaInAs/InP Modulation Doped Field Effect Transistors are investigated for millimeter wave device applications. AlInAs/GaInAs/InP MODFETs with gate lengths varying from 1.0 micron to 0.1 micron have been successfully fabricated and characterized at dc and microwave frequencies. Measured unity current gain cutoff frequencies between 100 to 120 GHz and power gain cutoff frequencies between 220 to 250 GHz are obtained for 0.2 micron gate length MODFETs. Unity current gain cutoff frequencies between 140 to 150 GHz are measured for 0.1 micron gate length MODFETs. Short gate length effects are studied to understand transport mechanisms in the MODFETs in order to further improve performance. Excess gate current due to hot electron effects are observed in short gate MODFETs. The RF and dc output conductance characteristics are measured and analyzed. New structures including variations in buffer layer design, atomic planar doping profiles, strained layer structures and mismatched structures are investigated. GRA

**N89-18232#** Defense Science Board, Washington, DC.
**REPORT OF THE DEFENSE SCIENCE BOARD TASK FORCE ON MILITARY SYSTEM APPLICATIONS OF SUPERCONDUCTORS Final Report**
Oct. 1988 88 p
(AD-A201125) Avail: NTIS HC A05/MF A01 CSCL 20C

The Task Force found a number of superconductivity applications that could result in significant new military capabilities, including electronics and high power applications. In particular, superconducting materials could enable significant military

improvements in: Magnetic Field Sensors with greatly increased sensitivity for improved detection and identification capability; Passive Microwave and Millimeter-wave Components enabling increased detection range and discrimination in clutter; Staring Infrared Focal Plane Array sensors incorporating superconducting electronics permitting significant range and sensitivity increases over current scanning IR sensors; Wideband Analog and Ultra-Fast Digital Signal Processing for radar and optical sensors; High Power Motors and Generators for ship and aircraft propulsion leading to: decreased displacement; drive system flexibility; increased range; or longer endurance on station; Magnets/Energy Storage for high power microwave, millimeter-wave or optical generators (e.g., free electron laser); capability for powering quiet propulsion systems; Electro-Magnetic Launchers capable of launching hypervelocity projectiles for antiarmor weapons and close-in ship defense weapons; and Magnetohydrodynamic (MHD) Propulsion enabling ultra quiet drives for submarines, torpedoes, and surface ships. GRA

**N89-18233#** Sandia National Labs., Albuquerque, NM.
**RADIATION-HARDENED MOS DEVICE RESPONSE TO HIGH DOSE RATE IRRADIATIONS AS A FUNCTION OF TEMPERATURE**
F. W. Sexton, James R. Schwank, and R. A. Kohler (Bell Telephone Labs., Inc., Allentown, PA.) 1989 5 p Presented at the HEART Conference, Melbourne, FL, 7 Feb. 1989
(Contract DE-AC04-76DP-00789)
(DE88-015258; SAND-88-2248C; CONF-890212-2) Avail: NTIS HC A02/MF A01

The effect of the device temperature during irradiation at high dose rates has been investigated for transistors and ICs over the MIL-STD temperature range, -55 to 125 C. At low temperatures, large increases in transistor leakage current was observed due to large shifts in the threshold voltages of parasitic field oxide transistors. The response of hardened field oxide devices and their effects on IC performance at high dose rates and low temperatures will be discussed for several different process conditions. DOE

**N89-18234#** Argonne National Lab., IL. Materials Science Div.
**THE UPPER CRITICAL FIELD OF HIGH TEMPERATURE SUPERCONDUCTORS**
G. W. Crabtree, W. K. Kwok, U. Welp, R. Burriel, H. Claus, K. G. Vandervoort (Illinois Univ., Chicago.), and J. Z. Liu 1988 18 p Presented at the 6th International Conference on Crystal-field Effects and Heavy-fermion Physics (ICCHFP-6), Frankfurt am Main, Fed. Republic of Germany, 18-21 Jul. 1988 Submitted for publication
(Contract W-31-109-eng-38)
(DE89-005828; CONF-880704-6) Avail: NTIS HC A03/MF A01

Resistive and magnetic measurements of the superconducting transition in good quality single crystals of YBa2Cu3O sub 7 - delta and La sub 2 minus x Sr sub x CuO4 and in good polycrystalline samples of Ba sub 1 minus x K sub x BiO3 are used to derive the temperature dependence and anisotropy of the upper critical field. Comparison of the results shows several common features, most notably the existence of upward curvature in the temperature dependence of the upper critical field. The definition of T sub c from resistance curves and the origin of the upward curvature in the upper critical field are discussed. DOE

**N89-18235#** Lawrence Livermore National Lab., CA.
**REACTIVE-ELEMENT EFFECT STUDIED USING ION IMPLANTATION**
W. E. King and K. S. Grabowski Nov. 1988 53 p Presented at the Metallurgical Society Fall Meeting and American Society for Metals Materials Week, Chicago, IL, 24 Sep. 1988
(Contract W-7405-eng-48)
(DE89-004774; UCRL-99716-Rev-1; CONF-880901-2-Rev-1)
Avail: NTIS HC A03/MF A01

Implantation of reactive elements into metals that form chromia layers upon exposure to high temperature oxidizing environments has a very large effect on the growth rate of the oxide and adhesion of the oxide to the base alloy. We have investigated the effect of Y ion implantation on the high temperature oxidation of Fe-24Cr using Rutherford backscattering spectroscopy, secondary ion mass spectroscopy, and electron microscopy. Analytical tools have been applied to determine the spatial distribution of Y, the microstructure of the oxide, and contribution of oxygen transport to the oxidation process. Results are compared with similar experiments in Fe-Cr alloys with Y additions and with results of cation and anion tracer diffusion experiments. DOE

**N89-18236#** Sandia National Labs., Albuquerque, NM.
**THE RESPONSE OF METAL-OXIDE-SEMICONDUCTOR DEVICES IRRADIATED AT HIGH TEMPERATURES**
James R. Schwank, Fred W. Sexton, Daniel M. Fleetwood, M. Steven Rodgers, and Kenneth L. Hughes 1989 17 p Presented at the 6th Symposium on Space Nuclear Power Systems, Albuquerque, NM, 9-12 Jan. 1989
(Contract DE-AC04-76DP-00789)
(DE89-005605; SAND-88-1860C; CONF-890103-6) Avail: NTIS HC A03/MF A01

To study the combined effects of high temperature and radiation on metal-oxide-semiconductor (MOS) integrated circuits (ICs), we have performed a series of experiments to characterize the response of MOS 16k static random access memories (SRAMs) irradiated at temperatures from 298 to 398 K. The irradiations were performed at dose rates approaching those of a spacebased nuclear reactor (approx. = 0.03 rad/s). Over the temperature range investigated, the failure dose of 16k SRAMs was found to decrease with increasing temperature due to complex interactions between radiation and temperature. Neither the failure mechanism nor the failure dose could be predicted from separate or independent measurements of room-temperature irradiation data and IC response preirradiation as a function of temperature. These results show that over the temperature range 298 to 398 K one cannot depend on elevated temperatures to extend the lifetime of ICs in a radiation environment. Extensive qualification tests must be performed if ICs on a space nuclear power platform are to be exposed to high radiation levels in this temperature range. At temperatures much higher than 400 K, however, defect annealing can significantly increase the radiation tolerance of MOS circuits. DOE

**N89-18237#** Sandia National Labs., Albuquerque, NM.
**OVERVIEW OF RADIATION HARDENING FOR SEMICONDUCTOR DETECTORS**
William R. Dawes, Jr. 1989 11 p Presented at the 5th European Symposium on Semiconductor Detectors: New Developments on Radiation Detectors, Munich, Fed. Republic of Germany, 21 Feb.1989
(Contract DE-AC04-76DP-00789)
(DE89-005606; SAND-89-0002C; CONF-890247-1) Avail: NTIS HC A03/MF A01

Semiconductor detectors for high energy physics applications offer the potential to obtain accurate particle spacial resolution and on-line data reduction. A significant disadvantage of semiconductor detectors and their associated circuitry however, is their sensitivity to radiation. Fortunately, a sufficient understanding of radiation effects on semiconductor devices exists that some classes of radiation tolerant semiconductor detectors are possible. DOE

**N89-18238#** Brookhaven National Lab., Upton, NY.
**SUPERCONDUCTING Tl-Ca-Ba-Cu-O THIN FILMS BY REACTIVE MAGNETRON SPUTTERING**
D. H. Chen, R. L. Sabatini, S. L. Qiu, D. DiMarzio, S. M. Heald, and H. Wiesmann 1988 8 p Presented at the 35th National Vacuum Symposium and 4th International Laser Science Conference, Atlanta, GA, 2 Oct. 1988
(Contract DE-AC02-76CH-00016)
(DE89-005649; BNL-41685; CONF-881002-41) Avail: NTIS HC A02/MF A01

Superconducting Tl-Ca-Ba-Cu-O thin films with T sub c onsets of 115 K and T sub c (R=O) of 95 K have been prepared by

reactive magnetron sputtering using Tl, Cu and Ca/Ba metal targets. It was found that proper thallium content is crucial for obtaining a high transition temperature. Wet oxygen and a sealed gold tube with additional thallium compounds were used to reduce the loss of thallium during annealing. X-ray diffraction spectra show that films with the sharpest transition at 95 K are predominantly c-axis oriented. XANES also shows a preferred c-axis orientation for the superconducting film, while for a nonsuperconducting film the near edge structure suggests greater disorder. X-ray microprobe fluorescence measurements indicate that these films are close to the 2122 stoichiometry. Scanning electron microscopy on these films is also presented. DOE

**N89-18239#** Argonne National Lab., IL. Materials Science Div.
**ROTATIONAL MAGNETIC PROCESSES IN A TYPE-II SUPERCONDUCTOR**
Liwen Liu, J. S. Kouvel (Chicago Univ., IL.), and T. O. Brun Aug. 1988 10 p Presented at the International Conference on Magnetism (ICM '88), Paris, France, 25 Jul. 1988 Submitted for publication
(Contract W-31-109-eng-38)
(DE89-005801; CONF-880705-12) Avail: NTIS HC A03

Magnetization-vector (M vec) measurements were made on a disk of compacted Nb powder rotated in a fixed field (H vec at 4.2 K. M vec is separable into a non-rotating diamagnetic component (approx. - H vec 4 pi for H less than and even greater than H sub c1) plus a penetrating-flux component which (for H greater than H sub c1) rotates with the sample but only up to some critical angle, indicating a frictional torque due to flux pinning. DOE

# 77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

**N89-18240#** International Centre for Theoretical Physics, Trieste (Italy).
**R2-MODEL OF STRONG GRAVITY**
Ali El-Tahir Sep. 1987 10 p
(DE88-704191; IC-87/241) Avail: NTIS (US Sales Only) HC A02/MF A01

A metric based on the simplest nonlinear Lagrangian which is identified with the square of the scalar curvature, R, is considered. The region where the metric is dominated by this Lagrangian is assumed to be confined to the vicinity of the gravitational source where gravity is most strong. Expressions for R and the metric were obtained as functions of the radial distance, exhibiting nonsingular solutions. DOE

**N89-18241#** International Centre for Theoretical Physics, Trieste (Italy).
**GENERALIZED METRIC OF GRAVITATION**
Ali El-Tahir Sep. 1987 9 p
(DE88-704192; IC-87/242) Avail: NTIS (US Sales Only) HC A02/MF A01

Useful expressions relating the metric components g sub rr and g sub tt of the static isotropic spacetime, and the scalar curvature, R, with the general Lagrangian are obtained. The generalized metric of gravity is introduced which is essentially nonsingular and reducible to cosmological and hence to Schwartzschild geometries by imposing a weak field constraint. DOE

**N89-18242#** International Centre for Theoretical Physics, Trieste (Italy).
**GENERALIZED VARIATIONAL PRINCIPLE OF GRAVITATION**
Ali El-Tahir Sep. 1987 7 p
(DE88-704193; IC-87/243) Avail: NTIS (US Sales Only) HC A02/MF A01

Generalized fourth order differential equations of gravitation are derived. Though similar to those earlier obtained from Lanczos, the present derivation is based on more general assumptions. The geometry-gravity dualism is discussed and the nonlinearity of gravitation is shown to be constrained by the curvature of space. DOE

**N89-18243#** International Centre for Theoretical Physics, Trieste (Italy).
**GRAVITATIONAL RADIATION REACTION IN THE NUT-de SITTER SPACETIME**
Malnuddin Ahmed Jul. 1988 14 p
(DE88-704235; IC-88/137) Avail: NTIS (US Sales Only) HC A03/MF A01

The equations for gravitational perturbation in the NUT-de Sitter spacetime are obtained. Using these equations, some preliminary calculations have been made with a view to constructing the retarded Green functions. Then with the help of the retarded Green functions, the radiative Green functions have been constructed. With the aid of these radiative Green functions, the reaction force on a particle is computed and this reaction force is then shown to account correctly for the energy and the angular momentum carried away by gravitational radiation to infinity and to the horizon. DOE

**N89-18244#** International Centre for Theoretical Physics, Trieste (Italy).
**INSTANTON AND EIGENMODES IN A TWO-DIMENSIONAL THEORY OF GRAVITY WITH TORSION**
K. Gediz Akdeniz, Ayse Kizilersu, and Emine Rizaoglu Jul. 1988 8 p
(DE88-704241; IC-88/156) Avail: NTIS (US Sales Only) HC A02/MF A01

Instanton-like solutions characterizing the geometric structure of the manifold are found to be in a two-dimensional theory of gravity with dynamical metric and torsion in the context of string theory. The eigenmodes for fluctuations of the solutions of the equations are also investigated and it has been shown that these solutions are stable. DOE

**N89-18245#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
**EQUATIONS OF MOTION FOR THE NEW D=10 N=1 SUPERGRAVITY-YANG-MILLS THEORY**
Sh. I. Vashakidze 1988 7 p
(DE88-704843; JINR-E-2-88-54) Avail: NTIS (US Sales Only) HC A02/MF A01

An on-shell superfield formulation of the dual (type IB) ten-dimensional N=1 supergravity coupled to Yang-Mills theory is presented. The coupling is completely specified in superspace by A-tensor supercurrent which, at the same time, takes into account all superstring corrections in the slope parameter expansion. The complete set of equations of motion is derived. DOE

**N89-18246#** Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics.
**BACKGROUND FIELD METHOD FOR NONLINEAR SIGMA-MODEL IN STOCHASTIC QUANTIZATION**
Naohito Nakazawa and Daiji Ennyu Mar. 1988 31 p
(DE88-755531; RRK-88-11) Avail: NTIS (US Sales Only) HC A03/MF A01

We formulate the background field method for the nonlinear sigma-model in stochastic quantization. We demonstrate a one-loop calculation for a two-dimensional non-linear sigma-model on a general Riemannian manifold based on our formulation. The formulation is consistent with the known results in ordinary quantization. As a simple application, we also analyze the multiplicative renormalization of the O(N) nonlinear sigma-model. DOE

**N89-18247#** Washington Univ., Seattle. Dept. of Physics.
**COSMOLOGICAL PERTURBATIONS FROM QUANTUM FLUCTUATIONS TO LARGE SCALE STRUCTURE**
James M. Bardeen 1988 34 p Presented at the 2nd Guo Shou-Jing Summer School on Particle Physics and Cosmology, Nanjing, China, 1 Jul. 1988
(Contract DE-AS06-88ER-40423)
(DE89-004574; DOE/ER-40423/01-C8; CONF-8807143-1) Avail: NTIS HC A03/MF A01

Classical perturbation theory is developed from the 3 + 1 form of the Einstein equations. A somewhat unusual form of the perturbation equations in the synchronous gauge is recommended for carrying out computations, but interpretation is based on certain hypersurface-invariant combinations of the variables. The formalism is used to analyze the origin of density perturbations from quantum fluctuations during inflation, with particular emphasis on dealing with double inflation and deviations from the Zel'dovich spectrum. The evolution of the density perturbation to the present gives the final density perturbation power spectrum, whose relationship to observed large scale structure is discussed in the context of simple cold-dark-matter biasing schemes. DOE

**N89-18248#** International Centre for Theoretical Physics, Trieste (Italy).
**QUANTUM DYNAMICAL SEMIGROUPS AND THE THEORY OF QUANTUM MEASUREMENTS**
G. C. Ghirardi, A. Rimini (Pavia Univ., Italy ), and T. Weber Jul. 1988 4 p
(DE88-704728; IC-88/178) Avail: NTIS (US Sales Only) HC A02/MF A01

The possible use of non-Hamiltonian type quantum evolution equations to find a solution to the problem of Wave Packet Reduction is discussed. A particular class of equations usually referred to as Quantum Dynamical Semigroup is considered. DOE

# 80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

No abstracts in this category.

# 81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

**N89-18249#** Air Force Engineering and Services Center, Tyndall AFB, FL. Engineering and Services Lab.
**AIR FORCE TECHNICAL OBJECTIVE DOCUMENT (TOD) FOR FY 88 Annual Report**
Jun. 1988 80 p
(AD-A200901; AFESC/ESL-TR-88-38) Avail: NTIS HC A05/MF A01 CSCL 01E

The Directorate of Engineering and Service Laboratory (HQ AFESC/RD) research and development program in civil engineering and environmental quality is detailed. The programs are directed toward expanding the technology base needed for developing state-of-the-art capabilities to support the wartime Engineering and Services' role in projection of aerospace power. These efforts encompass activities in the areas of aerospace operating surfaces, utilities, and fire protection technology. In addition, environmental research is pursued to assure that compliance with material environmental regulations will not impede Air Force operations. GRA

# 82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

**N89-18250#** Office of Technology Assessment, Washington, DC.
**BOOK PRESERVATION TECHNOLOGIES**
May 1988 125 p
(PB88-212410; OTA-O-375) Avail: NTIS HC A05/MF A01; also available SOD HC $5.00 as 052-003-01103-4 CSCL 05B

The problem of acid deterioration of books is analyzed along with the program under way at the Library of Congress. The program at the Library involves the chemical treatment of books in a unique and effective process that, however, also presents some new engineering and safety concerns. Because of these concerns, the House of Representatives Committee on Appropriations requested this independent review of the Library's system and other available or potential processes. OTA has evaluated the Library's process and program with a focus on effectiveness and safety, and compared it to available alternatives. OTA has also developed information and analyses useful to other major libraries in the Nation that are faced with the same problem of perserving valuable books and papers. Author

**N89-18251** Temple Univ., Philadelphia, PA.
**A STUDY OF THE DESIGN, DATA COLLECTION, DISSEMINATION AND MAINTENANCE OF A SOURCE COMMAND, CONTROL AND COMMUNICATIONS INTEROPERABILITY (C3I) DATABASE DIRECTORY FOR THE DEPARTMENT OF DEFENSE (DOD) RESEARCHER/PLANNER Ph.D. Thesis**
Frank D. Curcio 1988 200 p
Univ. Microfilms Order No. DA8818771

A source command, control and communications interoperability (C3I) Database Dictionary was designed and developed based on guidance and information provided by DTIC. C3I related source databases were identified and investigated by the Joint Tactical Command, Control, and Communications Agency database survey and are available for DOD research and planning on a restricted need-to-know basis. Dissert. Abstr.

**N89-18252** Lehigh Univ., Bethlehem, PA.
**DEVELOPMENT OF AN INCREMENTAL PARSER FOR LALR(1) LANGUAGES Ph.D. Thesis**
Ali Mousa Jaber 1988 189 p
Avail: Univ. Microfilms Order No. DA8817473

The feasibility is examined of developing an incremental parser for LALR(1) languages. For this purpose, a fairly decent source language was chosen and an incremental parser for this language was actually written in PASCAL. The source language was introduced in terms of a production rules of the grammar and the syntax diagrams. An LALR parsing algorithm presented by A. V. Aho, and J. D. Ullman is presented. An introduction about the LR parsing technique and a background on the of parsing are given. Analysis of the algorithm is shown. The algorithm consists of two parts, the parsing table, and the driver routine. The parsing table is created dynamically using pointers. A strategy is described for developing an incremental parser by combining the parser and the screen editor. The method was used to develop an incremental parser for the source language. The basic data structure is presented which is needed to develop the system. The system environment, the syntax tree management, and error handling are discussed. Algorithms and examples implementing both editor commands are presented. Dissert. Abstr.

**N89-18253*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**FY 1988 SCIENTIFIC AND TECHNICAL REPORTS, ARTICLES, PAPERS AND PRESENTATIONS**
Joyce E. Turner, comp. Oct. 1988 67 p
(NASA-TM-100346; NAS 1.15:100346) Avail: NTIS HC A04/MF A01 CSCL 05B

This document presents formal NASA technical reports, papers published in technical journals, and presentations by MSFC personnel in FY 88. It also includes papers of MSFC contractors. After being announced in STAR, all of the NASA series reports may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. The information in this report may be of value to the scientific and engineering community in determining what information has been published and what is available. Author

**N89-18254#** Technische Hogeschool Twente, Enschede (Netherlands). Dept. of Computer Science.
**FORMALIZING THE DATA AND KNOWLEDGE MODEL**
Maurice A. W. Houtsma and Herman Balsters Jul. 1988 27 p
(MEMO-INF-88-23; ISBN-9-03-650185-7; ETN-89-93830) Avail: NTIS HC A03/MF A01

The Data and Knowledge (Houtsma 87) model, a semantic data model, based on the ER model, whose main characteristics are the concepts of generalization, inheritance, and knowledge rules was formalized. These knowledge rules describe how to compute the value of so-called virtual attributes; these attributes are subject to inheritance according to generalization paths (ISA-hierarchies), just like normal attributes. The formalization is performed by means of a strictly mathematic, set-oriented data model. Every aspect of modeling is expressed in terms of functions, which are certain sets of orders paired. Thus it is possible to define a precise meaning for every application modeled by means of the Data and Knowledge model. In particular, virtual attributes are formalized as view definitions ranging over arbitrary database states. These view definitions are structured in so-called layers, which are the result of a stratification process. ESA

**N89-18255#** Air Force Office of Scientific Research, Bolling AFB, Washington, DC.
**AFOSR (AIR FORCE OFFICE OF SCIENTIFIC RESEARCH) TECHNICAL REPORT SUMMARIES Quarterly Report, No. 2, Apr. - Jun. 1988**
Debra Tyrrell Sep. 1988 510 p
(AD-A200935; AFOSR-88-0938TR) Avail: NTIS HC A22/MF A01 CSCL 05B

The Air Force Office of Scientific Research (AFOSR) Technical Report Summaries, published quarterly of each calendar year, consist of a brief summary of each AFOSR Technical Report received in the Technical Information Division and submitted to the Defense Technical Information Center for that quarter. GRA

**N89-18256#** Naval Postgraduate School, Monterey, CA.
**SEMANTIC SHORTHCOMINGS OF DATABASE MANAGEMENT SYSTEMS BASED ON RELATIONAL MODEL M.S. Thesis**
Jonathan S. Wall Jun. 1988 97 p
(AD-A200974) Avail: NTIS HC A05/MF A01 CSCL 12G

To many critics and researchers, semantic meagerness is the main limitation of relational database management systems. The burden placed on users to remember attribute names and their domains is discussed and difficulties associated with the lack of set as a type for an attribute is examined. This thesis explores the implications to high-level query languages necessitated by a set-type attribute. The allowance of semantically improper joins by DBMS is studied as is the lack of strong data type checking. The semantic shortcomings of system-chosen access paths is discussed. These problems are followed by recommended solutions. GRA

**N89-18257#** North Carolina Univ., Chapel Hill. Dept. of Computer Science.
**INTELLIGENT SEARCH OF FULL-TEXT DATABASES**
Susan Gauch and John B. Smith 1987 10 p
(Contract N00014-86-K-0680)
(AD-A201088; TR88-035) Avail: NTIS HC A02/MF A01 CSCL 12G

This project applies expert system technology to the task of searching online collections of documents. We are developing an intelligent search intermediary to help end-users locate relevant passages in large full-text databases. Our expert system will automatically reformulate contextual Boolean queries to improve search results and will present retrieved passages in decreasing order of relevance. It differs from other intelligent database functions in two ways: it works with semantically unprocessed text and the expert systems contains a knowledge base of search strategies independent of any particular content domain. The goals for our current project are to demonstrate the feasibility of the approach and to evaluate the effectiveness of the system through a controlled experiment. While the work we report here has limited objectives, the system and techniques are general and can be extended to large, real-world databases. GRA

**N89-18258#** North Carolina Univ., Chapel Hill. Dept. of Computer Science.
**AN EXPERT SYSTEM FOR SEARCHING IN FULL-TEXT**
Susan Gauch and John B. Smith 1988 17 p
(Contract N00014-86-K-0680)
(AD-A201091) Avail: NTIS HC A03/MF A01 CSCL 05B

This project applies expert system technology to the task of searching online full-text documents. We are developing an intelligent search intermediary to help end-users locate relevant passages in large full-text databases. Our expert system automatically reformulates contextual Boolean queries to improve search results and presents retrieved passages in decreasing order of estimated relevance. It differs from other intelligent database functions in two ways: it works with semantically unprocessed text and the expert systems contains a knowledge base of search strategies independent of any particular contend domain. The goals for the current project are to demonstrate the feasibility of the approach and to evaluate the effectiveness of the system through a controlled experiment. While the work reported here has limited objectives, the system and techniques are general and can be extended to large, real-world databases. GRA

**N89-18259*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**BIBLIOGRAPHY OF LEWIS RESEARCH CENTER TECHNICAL PUBLICATIONS ANNOUNCED IN 1986**
May 1987 349 p
(NASA-TM-89887; E-3574; NAS 1.15:89887) Avail: NTIS HC A15/MF A01 CSCL 05B

This compilation of abstracts describes and indexes the technical reporting that resulted from the scientific and engineering work performed and managed by the Lewis Research Center in 1986. All the publications were announced in the 1986 issues of Scientific and Technical Aerospace Reports (STAR) and/or International Aerospace Abstracts (IAA). Included are research reports, journal articles, conference presentations, patents and patent applications, and theses. Author

**N89-18403*#** National Aeronautics and Space Administration, Washington, DC.
**DATA SYSTEMS**
Paul H. Smith *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 127-145 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 05B

# 83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

No abstracts in this category.

# 84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

**N89-18260#** Committee on Appropriations (U.S. Senate).
**DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT AND CERTAIN INDEPENDENT AGENCIES APPROPRIATIONS FOR FISCAL YEAR 1989, PART 2**
Washington, DC GPO 1988 687 p Hearings on H.R. 4800 before the Committee on Appropriations, 100th Congress, 2nd Session, 29-30 Mar., 12 Apr., 18-19 Apr., 26 Apr., and 8 Jun. 1988
(S-Hrg-100-799-Pt-2; GPO-88-870) Avail: Committee on Appropriations, Senate, Washington, DC 20515 HC free; SOD HC $19.00 as 552-070-05046-1

Hearings before a subcommittee of the Senate Committee on Appropriations are presented for the Council on Environmental Quality, Department of Housing and Urban Development, Environmental Protection Agency, Federal Emergency Management Agency, National Academy of Sciences, and National Aeronautics and Space Administration. All written testimony and submittals for the record are also included. For individual titles, see N89-18261 through N89-18262.

**N89-18261#** Committee on Appropriations (U.S. Senate).
**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**
*In its* Department of Housing and Urban Development and Certain Independent Agencies Appropriations for Fiscal Year 1989, Part 2 1988 p 537-676 (For primary document see N89-18260 10-84)
Avail: Committee on Appropriations, Senate, Washington, DC 20515 HC free; SOD HC $19.00 as 552-070-05046-1

Hearings before a subcommittee of the Senate Committee on Appropriations are presented along with justifications for research and development, construction of facilities, space flight and communications, space station cost increases, and cost overruns. Equal opportunity employment, international cooperation, shuttle safety, and space station user community involvement were also discussed. B.G.

**N89-18262#** Committee on Appropriations (U.S. Senate).
**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. ADVANCED SOLID ROCKET MOTOR PROGRAM**
*In its* Department of Housing and Urban Development and Certain Independent Agencies Appropriations for Fiscal Year 1989, Part 2 1988 p 1139-1170 (For primary document see N89-18260 10-84)
Avail: Committee on Appropriations, Senate, Washington, DC 20515 HC free; SOD HC $19.00 as 552-070-05046-1

Hearings before a subcommittee of the Senate Committee on Appropriations are presented. Justifications for upgrading the solid rocket motor boosters for the shuttle systems are examined. All written testimony and submittals for the record are also included. B.G.

# 85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

**N89-18263#** Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID. Electric and Hybrid Propulsion Battery Test Working Force.
**A SIMPLIFIED VERSION OF THE FEDERAL URBAN DRIVING SCHEDULE FOR ELECTRIC VEHICLE BATTERY TESTING**
Aug. 1988 40 p
(Contract DE-AC07-76ID-01570)
(DE89-004839; DOE/ID-10146) Avail: NTIS HC A03/MF A01

A simple version of the Federal Urban Driving Schedule (FUDS) has long been sought after by those involved in electric vehicle battery testing to: (1) reduce the cost of hardware required to test electric vehicle batteries and record the data, (2) extract information that cannot be obtained from a continuously transient cycle, and (3) decrease the uncertainty in range determination by shortening the cycle. The methodology and results of this effort by the EHP Battery Test Working Task Force for a simplified FUDS battery discharge test cycle (called the SFUDS79) is presented. This battery test cycle may be used to replace the constant-rate discharge tests which are presently used to characterize batteries for electric vehicles, and offers an alternative to the FUDS test while providing the same information regarding battery range and cycle life. DOE

# 88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

# 89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

**N89-18264** Pennsylvania Univ., Philadelphia.
**POLARIMETRY AND SPECTROPHOTOMETRY OF THE MASSIVE CLOSE BINARY DH CEPHEI Ph.D. Thesis**
Michael Francis Corcoran 1988 235 p
Avail: Univ. Microfilms Order No. DA8816164

DH Cep is a massive and close binary and a member of the young open cluster NGC 7380. Spectroscopically this system is double lined, classified as type O6+O6. Photometrically, the system has been known to show small light variations phase locked to the radial velocity variations; these light variation characterize the star as an ellipsoidal variable. Four color linear polarimetry, archival UV spectra taken by IUE and X-ray measures obtained by the Einstein satellite provide the first detailed analysis of this important system. Polarization measures demonstrate the variability of the circum-binary scattering environment, identify the scattering medium as electrons and indicate a large scale change in the intrinsic polarization of the system. UV spectral analysis is used to determine the composite photospheric temperature, the component masses and spectral classifications, the degree of mass loss, and the distribution of interstellar matter along the line of sight to the binary. Dissert. Abstr.

**N89-18265** California Univ., Santa Cruz.
**THE LATE-TIME SPECTRA OF SUPERNOVAE Ph.D. Thesis**

Philip Alfred Pinto 1988 155 p
Avail: Univ. Microfilms Order No. DA8813348

The theme of this research is radiation transport in supernovae. In the first part, a Sobolev method for solving multilevel, non-LTE radiative transfer problems in moving atmospheres is described which is designed to model the optical and IR spectra in supernovae of Types 1 and 2. This method is used to examine the process of spectrum formation in expanding, low density atmospheres where lines are the dominant source of opacity. Sample calculations are presented of the spectra of Type 1a and 1b supernovae. In the second part, four papers are presented interpreting observations of Supernovae 1987A made from wavelengths inaccessible from the ground. These papers are briefly detailed. Dissert. Abstr.

**N89-18266** Australian National Univ., Canberra.
**INFRARED STUDIES OF THE STRUCTURE OF THE GALAXY Ph.D. Thesis**
Roberto Alejandro Ruelas-Mayorga 1987 567 p
Avail: Univ. Microfilms Order No. DA8807284

A simple three component model of the Galaxy is presented. The Galaxy is represented by: (1) a disk whose stellar density decreases exponentially with distance from the galactic center as well as perpendicularly as a function of height above or below the galactic plane; (2) plus a ring considered to be an enhancement of the disk and finally; (3) an oblate spheroid meant to represent the galactic bulge. The absorbing material is also assumed to be distributed as an exponential layer. Based on this model and the derived values of the constants, a series of stellar count predictions for the K-magnitude were made. These predictions were compared to those made by the Bahcall and Soneira model of the Galaxy. Stellar counts along the galactic plane were obtained, and were fitted to the galactic model described. The model constants utilized in fitting the stellar counts are those derived from the model fit to the 2.4 micrometer observed integrated flux. Dissert. Abstr.

**N89-18267** Brigham Young Univ., Provo, UT.
**THE YOUNG OPEN CLUSTERS NGC 2244 AND NGC 2264: NEW OBSERVATIONS AND A COMPARATIVE STUDY Ph.D. Thesis**
Mario Ruben Perez 1988 370 p
Avail: Univ. Microfilms Order No. DA8821907

Northern Monoceros is a region rich in emission nebulosity, opaque clouds, dark globules, and young open clusters and could be considered a good environment and lab to detect and study young stellar objects. From this region, the young open clusters NGC 2244 and NGC 2264, known to be sites of very active star formation and which are among the youngest in the Galaxy, were selected for study. Stellar data was secured in the cluster fields with different photometric systems and the spectroscopic system, IDS, in three observing seasons. These new data allowed the assessment of membership, spectral types and the estimation of extinctions, distances, abundances, variability, cluster ages and masses, and several other important astrophysical parameters. The picture that emerges from analysis is that the cluster NGC 2244 seems to be formed only by massive stars, whereas, two well differentiated groups of massive stars and low mass stars appear to form NGC 2264. It was also found that the clusters lie in different arms of the Galaxy and they have been originated by dissimilar mechanisms in different epochs. Dissert. Abstr.

**N89-18268*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**OBSERVATIONS OF THE 8 DECEMBER 1987 OCCULTATION OF AG+40 DEG 0783 BY 324 BAMBERGA**
R. L. Millis, L. H. Wasserman, O. G. Franz, E. Bowell, R. A. Nye, D. T. Thompson, N. M. White, W. B. Hubbard, R. E. Eplee, Jr., and L. A. Lebofsky et al 1988 17 p Prepared in cooperation with Lowell Observatory; Arizona Univ.; Ball Aerospace Systems Div.; Shanghai Observatory; Computer Sciences Corp.; International Occultation Timing Assn.; and Lick Observatory
(Grant NsG-7045)
(NASA-CR-184785; NAS 1.26:184785) Avail: NTIS HC A03/MF A01 CSCL 03A

The occultation of AG+40 deg 0783 by 324 Bamberga on 8 December 1987 was observed at 13 sites in the United States, Japan, and China. At four sites the event was observed photoelectrically; the other observations were visual. A least-squares fit of a circular limb profile to the data gives a diameter of 227.6 + or - 1.9 km. However, this solution is inconsistent with a negative visual observation near the northern edge of the ground track. The inconsistency cannot be removed by assuming an elliptical profile. The data suggest that Bamberga, despite its low-amplitude lightcurve, may depart significantly from a spherical or ellipsoidal shape. The asteroid also appears to be at least 10 percent smaller than indicated by infrared radiometry. Author

**N89-18269#** Naval Research Lab., Washington, DC.
**REFOCUSING A RADIO TELESCOPE TO IMAGE SOURCES WITHIN THE NEARFIELD OF THE ANTENNA ARRAY**
William H. Carter 17 Oct. 1988 40 p
(AD-A200929; NRL-9141) Avail: NTIS HC A03/MF A01 CSCL 03A

A theory is developed from three forms of the Fraunhofer approximation that describes a method for a refocusing a radio telescope to image sources that are within the nearfield of the antenna array. In the first, section the Fraunhofer approximations of the first, second, and third kinds are derived and studied in applications to the propagation of a scalar field amplitude from sources to detectors. In the second section these approximations are applied to the propagation of the cross-spectral density function of coherence theory. Important differences between the conditions for validity and the mathematical structure of these three approximations are described. In the final section a theoretical model is developed to describe the operation of a radio telescope using the theory developed in the first two sections. This model is used to develop a method for refocusing a radio telescope to image sources that are within the nearfield of the antenna array. Two methods for refocusing the telescope are described that would require no modification to most existing telescopes but would require some modifications to the data processing software.
GRA

# 90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics*.

**N89-18270** Washington Univ., Seattle.
**GLOBAL PROPERTIES OF THE SCULPTOR AND FORNAX DWARF ELLIPTICAL GALAXIES Ph.D. Thesis**
Paul Burdette Eskridge 1987 176 p
Avail: Univ. Microfilms Order No. DA8810526

The global properties of the Sculptor and Fornax dwarf elliptical galaxies are examined. These are determined from star counts from Schmidt plates. Luminosity functions were constructed. Radial profiles were compared with King (1966) models and exponential laws. Two-dimensional structure in both systems was investigated using residual maps of the raw star counts minus symmetric fits. These maps clearly show internal structure. Dissert. Abstr.

**N89-18271** Washington Univ., Seattle.
**THE STRUCTURAL PARAMETERS AND INITIAL MASS FUNCTIONS OF MAGELLANIC CLOUD STAR CLUSTERS Ph.D. Thesis**
Mario Luis Mateo 1987 545 p
Avail: Univ. Microfilms Order No. 8810562

Photoelectric and CCD photometry was obtained for a sample of 69 star clusters in the Magellanic Clouds (MCs). The calibration techniques and errors involved in these observations are described in detail. The systematic precision of the photometry is better than 2 percent. Digital aperture photometry was performed on the CCD frames. Total and half-light magnitudes and colors were determined for all the program clusters. Many fundamental structural parameters were determined for the program clusters

and these were compared with results for Galactic globular and open clusters. Main sequence luminosity functions of six of the program clusters with deep CCD observations were determined. These clusters span a large range in age and a significant range in metallicity. The analysis of these data were fully described and the errors and fundamental shortcomings of the procedures were discussed. The luminosity functions were transformed to mass functions using theoretical isochrones. Standard isochrones and models incorporating convective overshooting were used in the analysis. The average initial mass functions of the MC clusters was compared with previous empirical and theoretical results.
Dissert. Abstr.

**N89-18272** Columbia Univ., New York, NY.
**HIGH-LATITUDE MOLECULAR CLOUDS AND INFRARED CIRRUS Ph.D. Thesis**
Hendrik Willem deVries 1988 258 p
Avail: Univ. Microfilms Order No. DA8815663

The high-latitude infrared cirrus clouds detected by IRAS are identified with atomic and molecular clouds. These clouds are small and show weak CO emission. On the basis of a distance of 100 pc they are characterized by a mass of a few solar masses and a radius of about 1 pc. Thermal radiation by dust as a result of heating by the diffuse interstellar radiation field is the most plausible origin of the cirrus emission at far-infrared wavelengths. On the basis of plausible assumptions regarding the uniformity of both the gas-to-dust ratio and the heating and cooling of the dust, the flux density at 100 micrometers from regions with low visual extinction should be a good tracer of the gas column density.
Dissert. Abstr.

**N89-18273** California Univ., Berkeley.
**PARKER INSTABILITY IN INTERSTELLAR MEDIUM WITH A REALISTIC GRAVITATIONAL FIELD AND A COMPUTER CODE FOR MAGNETOHYDRODYNAMICS Ph.D. Thesis**
Ahmet Togo Giz 1987 159 p
Avail: Univ. Microfilms Order No. DA8813873

In the 1960's, E. N. Parker discovered a magnetic analogue of the Raleigh-Taylor instability, known as the Parker instability, which could lead to the formation of the giant molecular cloud complexes. Magnetic fields offer no resistance in the field direction. If a gas permeated by a horizontal magnetic field is perturbed tilting the field lines, the gas can slide down the lines concentrating in the valleys, causing them to sink even lower. This scenario depends on the stiffness of the equation of state of the gas, and on to what extent the gas is being supported by the magnetic field. Cosmic rays will tend to further destabilize the medium as they are coupled to the gas only through the magnetic field. Parker instability is analyzed with a realistic gravitational field which is consistent with an isothermal distribution of stars forming the gravitational mass.
Dissert. Abstr.

**N89-18274** Leicester Univ. (England).
**MODEL ATMOSPHERES FOR ACCRETING SYSTEMS Ph.D. Thesis**
J. R. E. Brooker 1987 264 p
Avail: Univ. Microfilms Order No. BRD-82602

The results are presented of calculating model atmospheres for the accretion column of a magnetic white dwarf. A basic stellar atmosphere calculation is refined to model the specific conditions at the base of an accretion column. Calculated spectra for a variety of different input conditions are shown. The calculated spectra are fitted with black body spectra in order to ascertain the errors associated with black body fitting of observed spectra. Simulated lightcurves are calculated using these model atmosphere spectra. The resultant lightcurves are folded through the EXOSAT detectors and used to fit lightcurves from the magnetic polar system AM Herculis. Following the assumption that a thin accretion disc around a supermassive black hole is the central power source for active galactic nuclei a large grid of model atmospheres is calculated. This grid is then used to calculate the spectrum from such a disc.
Dissert. Abstr.

**N89-18275** California Univ., San Diego.
**A STUDY OF TEMPORAL-SPECTRAL BEHAVIOR OF HERCULES X-1: A BINARY X-RAY PULSAR Ph.D. Thesis**
Yang Soong 1988 195 p
Avail: Univ. Microfilms Order No. DA8817175

The 12 to 180 keV temporal and spectral variations of the rotating highly magnetized neutron star, Hercules X-1, in the accreting close binary stellar system are studied. Analysis of these variations with respect to different time scales and energy ranges provides for an semi quantitative understanding of the accretion, emission, and beam formation mechanisms in a physical setting unobtainable in a lab. The results of the study are given and discussed.
Dissert. Abstr.

**N89-18276*#** Texas Univ., Austin. Dept. of Astronomy.
**THE DISTRIBUTION OF DARK MATTER, GALAXIES, AND THE INTERGALACTIC MEDIUM IN A COLD DARK MATTER DOMINATED UNIVERSE**
Dongsu Ryu, Ethan T. Vishniac, and Wei-Hwan Chiang Nov. 1988 46 p Prepared in cooperation with Fermi National Accelerator Lab., Batavia, IL Sponsored in part by NASA and DOE
(Grant NSF AST-84-51736)
(NASA-CR-181450; NAS 1.26:181450; FERMILAB-Publ-88/187-A)
Avail: NTIS HC A03/MF A01 CSCL 03B

The evolution and distribution of galaxies and the intergalactic medium (IGM) have been studied, along with collisionless dark matter in a Universe dominated by cold dark matter. The Einstein-deSitter universe with omega sub 0 = 1 and h = 0.5 was considered (here h = H sub 0 bar 100/kms/Mpc and H sub 0 is the present value of the Hubble constant). It is assumed that initially dark matter composes 90 pct and baryonic matter composes 10 pct of total mass, and that the primordial baryonic matter is comprised of H and He, with the abundance of He equal to 10 pct of H by number. Galaxies are allowed to form out of the IGM, if the total density and baryonic density satisfy an overdensity criterion. Subsequently, the newly formed galaxies release 10 to the 60th ergs of energy into the IGM over a period of 10 to the 8th years. Calculations have been performed with 32 to the 3rd dark matter particles and 32 to the 3rd cells in a cube with comoving side length L = 9.6/h Mpc. Dark matter particles and galaxies have been followed with an N-body code, while the IGM has been followed with a fluid code.
Author

**N89-18277#** International Centre for Theoretical Physics, Trieste (Italy).
**QUANTUM THEORY OF COSMOLOGICAL PERTURBATIONS**
V. F. Mukhanov May 1988 17 p
(DE88-704696; IC-88/90) Avail: NTIS (US Sales Only) HC A03/MF A01

The metric perturbations of scalar type in the isotropic Universe filled by a scalar field are considered. The action for such perturbations in terms of gauge invariant variables is obtained and a self-consistent quantum theory is constructed. The inhomogeneities spectrum in the inflationary Universe is calculated.
DOE

**N89-18278#** International Centre for Theoretical Physics, Trieste (Italy).
**ASTROPARTICLE PHYSICS (1988)**
A. Salam 1988 36 p
(DE88-704699; IC-88/109) Avail: NTIS (US Sales Only) HC A03/MF A01

A review of the present situation in particle physics, astrophysics and cosmology is attempted, which emphasizes the unity of the subject.
DOE

**N89-18279#** International Centre for Theoretical Physics, Trieste (Italy).
**STANDING NON-DISSIPATIVE SHOCKS IN BLACK HOLE ACCRETION AND WINDS**
Sandip K. Chakrabarti Jul. 1988 33 p

(DE88-704709; IC-88/151) Avail: NTIS (US Sales Only) HC A03/MF A01

We present all non-dissipative shock solutions for stationary, axially symmetric and rotating adiabatic flows of small transverse thickness in black hole potential. We show that for a given initial and final states of the flow, there can be as many as four formal shock locations in both the accretion and the winds. Only two (three) of these locations are acceptable for accretion onto black holes (neutron stars) and three of these locations are acceptable for winds. We prove that the shock strength and the temperature jump have a lower limit which does not depend upon the parameters of the flow or the force field in which the flow moves and is only a function of the adiabatic index of flow. DOE

**N89-18280#** International Centre for Theoretical Physics, Trieste (Italy).

**ISENTROPIC COMPRESSION WAVES IN BLACK HOLE ACCRETION AND WINDS**

Sandip K. Chakrabarti Jul. 1988 41 p

(DE88-704711; IC-88/153) Avail: NTIS (US Sales Only) HC A03/MF A01

We present all the isentropic shock solutions for stationary, axially symmetric and rotating adiabatic flows of small transverse thickness in black hole potential. We classify the whole parameter space spanned by the accretion rate, energy and the angular momentum of the flow in terms of the number of shock solutions. We show that in some regions of the parameter space, as many as four such solutions exist for all of which the dissipation of energy remains the same but the shock strength varies. We calculate the shock locations and the shock strengths for the whole parameter space. We show that the shocks cannot be arbitrarily weak. The lower limit of shock strength is independent of any of the flow parameters, and depend solely upon the adiabatic index. DOE

**N89-18281#** International Centre for Theoretical Physics, Trieste (Italy).

**STANDING ISOTHERMAL SHOCKS IN ADIABATIC BLACK HOLE ACCRETION AND WINDS**

Sandip K. Chakrabarti Aug. 1988 34 p

(DE88-704731; IC-88/187) Avail: NTIS (US Sales Only) HC A03/MF A01

Presented are solutions for the isothermal standing shocks in the stationary, axially symmetric, transonic, adiabatic flows with polytropic, rotating fluid configurations of small transverse thickness in the black hole geometry. It is shown that these shocks dissipate both the energy and the entropy. The lower limits of shock dissipation and shock strength are derived and the detailed nature of the energy loss at the shock and the location of the shock are provided for the whole parameter space spanned by the initial energy, the accretion rate and the angular momentum of the flow. We show that up to two per cent of the rest mass energy can be radiated away at the shock. DOE

**N89-18282#** International Centre for Theoretical Physics, Trieste (Italy).

**STANDING SHOCKS IN ADIABATIC BLACK HOLE ACCRETION OF ROTATING MATTER**

Marck A. Abramowicz and Sandip K. Chakrabarti Aug. 1988 25 p

(DE88-704756; IC-88/252) Avail: NTIS (US Sales Only) HC A03/MF A01

We present all the solutions for stationary, axially symmetric, transonic, adiabatic flows with polytropic, rotating fluid configurations of small transverse thickness, in an arbitrarily chosen potential. Special attention is paid to the formation of the standing shocks in the case of black hole accretion and winds. We point out the possibility of three types of shocks depending upon three extreme physical conditions at the shocks. These are: Rankine-Hugoniot shocks, isentropic compression waves, and isothermal shocks. We write down the shock conditions for these three cases and discuss briefly the physical situations under which these shocks may form. DOE

**N89-18283#** International Centre for Theoretical Physics, Trieste (Italy).

**SYSTEMATIC STUDY OF THE STANDING SHOCKS IN ASTROPHYSICAL FLOWS NEAR A COMPACT OBJECT**

Sandip K. Chakrabarti Aug. 1988 60 p

(DE88-704758; IC-88/254) Avail: NTIS (US Sales Only) HC A04/MF A01

We study the standing dissipative and non-dissipative shocks and the isentropic compression waves systematically in the thin, rotating, adiabatic astrophysical flows, such as accretion or winds, near the black holes and the neutron stars. The flow is assumed to be in transverse equilibrium and the dissipation is allowed only at the shocks. We classify the whole parameter space spanned by the accretion rate M, the energy E and the angular momentum lambda according to whether a shock solution can exist or not. Apart from conserving the baryon flux and the net momentum flux, flows at these discontinuities (collectively refered to as shocks) may conserve energy (Rankine-Hugoniot shocks), entropy (isentropic compression waves), or just be isothermal (isothermal shocks) according to three extreme physical processes which may take place near the shocks. We also show that for a given pre-shock and the post-shock parameters the shock locations are not unique. We derive an invariant Mach number relation at the shock and from this show that the shocks cannot be arbitrarily weak. The lower limit of the shock strength is independent of the initial parameters of the flow and the governing force field, but depends only upon the adiabatic index of the flow. DOE

**N89-18284#** Wyoming Univ., Laramie.

**STRUCTURE OF INFRARED-BRIGHT CIRCUMSTELLAR NEBULAE Final Report, 1 Feb. 1985 - 31 Jan. 1988**

Paul Johnson and Harley Thronson Aug. 1988 3 p

(Grant AF-AFOSR-0038-85; AF Proj. 2311)
(AD-A200733; AFOSR-88-1094TR) Avail: NTIS HC A02/MF A01 CSCL 03B

Detailed multi-wavelength, near-infrared maps and polarimetry have been made of AFGL 2591, AFGL 490, Cep A, S140, AFGL 618, and OH 0739-14, stars embedded in dust that absorbs starlight and reradiates strongly in the mid-infrared. A general Mie scattering model has been coded to yield intensity and polarization maps of bipolar nebulae in the infrared and visible parts of the spectrum. Hat Creek Millimeter Interferometer maps of AFGL 618 and NGC 7027 have been obtained which are being reproduced and combined with data taken at the Wyoming Infrared Observatory to produce detailed studies of these objects. The construction and testing of a photoelastic modulator data acquisition system was completed and is currently being used to acquire polarimetry of dust enshrouded stars. GRA

**N89-18285** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.

**THE STATUS OF OBSERVATION AND UNDERSTANDING OF QUASI-PERIODIC OSCILLATIONS (QPO)**

Guenther Hasinger Jun. 1988 22 p Presented at the Symposium on the Physics of Neutron Stars and Black Holes, Tokyo, Japan, 1-3 Feb. 1988 Submitted for publication

(MPE-Preprint-124; ETN-89-93804) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514
Eggenstein-Leopoldshafen 2, Fed. Republic of Germany

Observations (including EXOSAT) of quasi-periodic oscillations (QPO) from lowmass X-ray binaries are reviewed, emphasizing similarities between the different sources. There are three modes of spectral behavior, called the horizontal, normal and flaring branch, which are strictly correlated with three types of QPO activity. The first discovered intensity-dependent QPO and low-frequency noise are observed exclusively on the horizontal branch. Normal-branch QPO are very common and all have similar frequencies. There is only one clear case of flaring-branch QPO. The observations are discussed in terms of a scenario where the different types of QPO have different origin, magnetospheric on the horizontal branch and nonmagnetospheric on the normal and flaring branch. The horizontal-normal branch transition is

highlighted. Broad band power spectra of high-mass X-ray binaries are compared to those of QPO sources. ESA

**N89-18286** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**X-RAY BINARIES AND RADIOPULSARS IN GLOBULAR CLUSTERS**
Frank Verbunt Jul. 1988 19 p Submitted for publication
(MPE-Preprint-125; ETN-89-93805) Copyright Avail:
Fachinformationszentrum Karlsruhe, 7514
Eggenstein-Leopoldshafen 2, Fed. Republic of Germany

The presence of relatively large numbers of low-mass X-ray binaries in globular clusters is explained as a consequence of tidal capture of single neutron stars by main-sequence or giant stars. The absolute numbers of such binaries is very uncertain, due to two major uncertainties: the number of single neutron stars in globular clusters is badly known, and the life time of lowmass X-ray binaries in their active state is very uncertain. The combination of these two uncertainties leads to an uncertainty in the predicted number of lowmass X-ray binaries of a factor 100. Smaller uncertainties arise because of limited knowledge of the cross sections for the different capture processes and because the degree of mass segregation in many clusters is unknown. Wide-binary radiopulsars are formed via the evolution of the (sub) giant/neutron star binaries. Single radiopulsars can be formed when a millisecond pulsar in a binary destroys its companion, or when a third star interacts with a binary containing a rapidly rotating neutron star. ESA

**N89-18287** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**A THIRD X-RAY SPECTRAL MODE IN Sco X-1: SIMILARITIES TO THE OTHER BRIGHT BULGE SOURCES**
Guenther Hasinger, William C. Priedhorsky, and John Middleditch (Los Alamos National Lab., NM.) Aug. 1988 24 p Submitted for publication
(MPE-Preprint-126; ETN-89-93806) Copyright Avail:
Fachinformationszentrum Karlsruhe, 7514
Eggenstein-Leopoldshafen 2, Fed. Republic of Germany

Although Sco X-1 normally shows two spectral/quasi-periodic oscillation (QPO) modes, during an EXOSAT observation 1986 March 12, is entered a third mode, in which the spectral hardness remained constant, the intensity decreased, and the power spectrum showed a broad noise component at 2 Hz. This mode is similar to the horizontal branch displayed by Cyg X-2, and suggests that the galactic bulge sources follow a common, Z-shaped spectral pattern. Transitions at the vertices of this pattern may represent the onset of disk instabilities, the transition from a thick to a thin disk, or transition through the Eddington limit. In all branches, Sco X-1 shows a noise continuum which cuts off at 60 Hz. No coherent pulsations are observed during this observation, with an upper limit of 0.3 pct for the frequency range 1 to 200 Hz; 0.5 pct from 200 to 1000 Hz; and 0.7 pct from 1000 to 200 Hz. ESA

# 91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights.

For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**N89-18288*#** Lunar and Planetary Inst., Houston, TX. Solar System Exploration Div.
**WORKSHOP ON MARS SAMPLE RETURN SCIENCE**
Michael J. Drake, ed., Ronald Greeley, ed., Gordon A. McKay, ed., Douglas P. Blanchard, ed., Michael H. Carr, ed., James Gooding, ed., Christopher P. McKay, ed., Paul D. Spudis, ed., and Steven W. Squyres, ed. 1988 200 p Workshop held in Houston, Tex., 16-18 Nov. 1987
(Contract NASw-4066)
(NASA-CR-183337; NAS 1.26:183337; LPI-TR-88-07) Avail: NTIS HC A09/MF A01 CSCL 03B

Martian magnetic history; quarantine issues; surface modifying processes; climate and atmosphere; sampling sites and strategies; and life sciences were among the topics discussed. For individual titles, see N89-18289 through N89-18372.

**N89-18289*#** California Inst. of Tech., Pasadena. Div. of Geological and Planetary Sciences.
**THE MARS OBSERVER DATABASE**
Arden L. Albee *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 25-29 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Mars Observer will study the surface, atmosphere, and climate of Mars in a systematic way over an entire Martian year. The observations of the surface will provide a database that will be invaluable to the planning of a future Mars sample return mission. Mars Observer is planned for a September 1992 launch from the Space Shuttle, using an upper-stage. After the one year transit the spacecraft is injected into orbit about Mars and the orbit adjusted to a near-circular, sun-synchronous low-altitude, polar orbit. During the Martian year in this mapping orbit the instruments gather both geoscience data and climatological data by repetitive global mapping. The scientific objectives of the mission are to: (1) determine the global elemental and mineralogical character of the surface material; (2) define globally the topography and gravitational field; (3) establish the nature of the magnetic field; (4) determine the time and space distribution, abundance, sources, and sinks of volatile material and dust over a seasonal cycle; and (5) explore the structure and aspects of the circulation of the atmosphere. The science investigations and instruments for Mars Observer have been chosen with these objectives in mind. These instruments, the principal investigator or team leader and the objectives are discussed. Author

**N89-18290*#** Lockheed Engineering and Management Services Co., Inc., Houston, TX.
**HOW SUCCESSFUL WERE THE LUNAR SAMPLING TOOLS: IMPLICATIONS FOR SAMPLING MARS**
J. H. Allton and C. B. Dardano *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 30-31 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Like the Mars Sample Return endeavor, the Apollo lunar-sample program began with definition of strategy for sample collection and of scientific requirements for sampling hardware design. Several lessons can be illustrated by specific tools. The evolution of drive tubes from narrow 2 cm diameter, thick-walled tubes (used on Apollo 11, 12 and 14) to 4 cm diameter, thin-walled tubes used on Apollo 15, 16, and 17) as an example of the improvements made possible during multiple missions. The original Apollo 11 drive tube was designed to work in fluffy soil; thus, only 50 percent of the relatively dense lunar soil was recovered, and the core was distorted. The final configuration resulted in nearly 100 pct recovery with little distortion. The surface samplers (Contact Soil Sampling Devices) were designed to collect the upper 100 micrometer or the upper 1 mm of soil. It was over 2 years after the mission before these particularly specific samplers were opened because interest in them waned. Both core tubes and surface samplers were difficult to open in the laboratory. The Apollo Lunar Sample Return Containers (ALSRCs) were constructed with one indium and 2 Viton seals. They were closed on the lunar surface. Interior container pressures measured upon return to the laboratory indicate that these seals were not reliable in the lunar environment. Also, choice of indium as a sealing material interfered with siderophile analyses of samples. Author

**N89-18291*#** Chicago Univ., IL.
**SAMPLES FOR ESTIMATING PRIMARY VOLATILES IN MARTIAN MAGMAS AND ANCIENT ATMOSPHERIC PRESSURES ON MARS Abstract Only**
A. T. Anderson, Jr. *In* Lunar and Planetary Inst., Workshop on

Mars Sample Return Science 1988 p 32 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Inclusions of glass are likely to be present in phenocrysts in volcanic rocks from Mars, because these occur in volcanic rocks from both Earth and Moon. The usefulness of the inclusions depends upon their size and composition. The compositions of tiny inclusions may be modified by diffusion during growth of the enclosing crystal, the modifications increasing with melt viscosity (silica). Slow cooling results in crystallization and possible redistribution of volatiles, the effects increasing with decreasing silica. Primary volatile concentrations are best sought in inclusions larger than about 50 micrometer diameter in olivine or chromite crystals from quickly cooled basaltic scoria. Such crystals may be present in sands, but it would be preferable to extract them from individual rocks which could be dated and compositionally characterized. This would allow eventual understanding of the role of time and place in outgassing and volcanism on Mars. Analyses of volatiles in inclusions of more siliceous glass in non-basaltic rocks will reveal whether deep outgassing occurs and whether surface volatiles are recycled. Most volcanic crystals contain inclusions, but large inclusions can be uncommon. In the case of terrestrial basalts sample masses of several hundred grams are generally sufficient. Author

**N89-18292*#** Brown Univ., Providence, RI. Dept. of Geological Sciences.
**CONSTRAINTS ON MARS SAMPLING BASED ON MODELS OF BASALTIC FLOW SURFACES AND INTERIORS**
J. C. Aubele and L. S. Crumpler *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 33-34 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Recent field observation and numerical modelling of the pattern and origin of vesicle zones and joints in terrestrial basaltic flows has resulted in increased understanding of the processes which affect flow surface morphology. This work has documented the ubiquitous occurrence of three vertical zones in basalt flows: (1) an upper vesicular zone; (2) a middle vesicle-free zone; and (3) a lower vesicular zone. The upper vesicular zone is generally about one-half of the total flow thickness. Computer modeling of the development of these zones confirms that vesicle zonation is a result of the nucleation, growth and rise of bubbles in solidifying lava and can be expected to occur in all basaltic flows. Degradation of basaltic flows, therefore, will produce vesicular blocks until the erosional level reaches the central vesicle-free zone. In addition, observation of terrestrial basaltic flows has shown that most thin (less than 10 m thick) flows have a regular pattern of orthogonal joints in vertical section in which the spacing of joints increases with depth beneath the flow surface. Using these studies we have performed a preliminary analysis of the Viking lander sites.
Author

**N89-18293*#** Hebrew Univ. of Jerusalem, Rehovot (Israel). Dept. of Soil and Water Sciences.
**THE SOILS OF MARS**
A. Banin *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 35-36 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

A mineralogical model for the Mars fine soil that includes as major components smectite clays absorbed and coated with amorphous iron oxyhydroxides and perhaps mixed with small amounts of better-crystalized iron oxides as separate phases is proposed. Also present as accessory minerals are sulfate minerals such as kieserite ($MgSO_4.H_2O$) and/or anhydrite ($CaSO_4$), rutile ($TiO_2$), and maghemite ($Fe_2O_3$) or magnetite ($Fe_3O_4$), the last two as magnetic components. Carbonates may be present at low concentrations only (less than 1 to 2 pct). However, a prime question to be addressed by a Mars Sample Return Mission shall be related to the mineralogical composition of the soil, and its spatial variability. Author

**N89-18294*#** Lunar and Planetary Inst., Houston, TX.
**THE RIDGED PLAINS AS A POSSIBLE LANDING SITE FOR THE MARS SAMPLE RETURN MISSION**
Nadine G. Barlow *In its* Workshop on Mars Sample Return Science 1988 p 37-38 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Differences in the shape and density of crater size-frequency distribution curves have been interpreted as indicators of different impactor populations. Within the inner solar system two production populations are seen. The signature of the first is recorded in the heavily cratered regions of the Moon, Mercury, and Mars and displays a multi-sloped distribution curve which cannot be described by a power law function at all crater diameters. The signature of the second population is seen in the lightly cratered lunar and Martian plains, where the size-frequency distribution curve can be approximated by a power law function of -3 differential slope in the 8- to 70-km diameter range. Based on data obtained from the Apollo lunar samples and crater flux estimates, the first population is believed to have been emplaced during the period of heavy bombardment which, at least on the Moon, ended about 3.8 BY ago. The second population has dominated the cratering record since that time and is commonly assumed to be due to comets and asteroids. Author

**N89-18295*#** Indiana Univ., Bloomington. Dept. of Geology.
**PRIMARY SEDIMENTARY STRUCTURES AND THE INTERNAL ARCHITECTURE OF A MARTIAN SAND BODY IN SEARCH OF EVIDENCE FOR SAND TRANSPORT AND DEPOSITION**
Abhijit Basu *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 39-40 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Lunar experiences show that unmanned sample return missions, despite limitations on sample size, can produce invaluable data to infer crustal processes, regolith processes, regolith-atmosphere/ionosphere interaction processes, etc. Drill cores provide a record of regolith evolution as well as a more complete sample of the regolith than small scoops and/or rakes. It is proposed that: (1) a hole be drilled in a sand body to obtain continuous oriented cores; a depth of about 10 m would be compatible with what we know of bed form hierarchy of terrestrial stream deposits; (2) two trenches, at right angles to each other and close to the drill-hole, be dug and the walls scraped lightly such that primary/internal sedimentary structures of the sand body become visible; (3) the walls of the trenches be made gravitationally stable by impregnation techniques; (4) acetate or other peels of a strip on each wall be taken; and (5) appropriately scaled photographs of the walls be taken at different sun-angles to ensure maximum ease of interpretation of sedimentary structures; and, to correlate these structural features with those in the core at different depth levels of the core. Author

**N89-18296*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**HOW WELL DO WE KNOW THE MARTIAN ABUNDANCES OF HIGHLY VOLATILE ELEMENTS**
Donald Bogard *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 41-42 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The table is given that summarizes four models based on observations and gives some reasonable inferences of each for Martian volatiles. The table columns give: (1) the volatile assumptions of the model; (2) the inferred Martian volatile concentrations relative to earth; (3) the N/36 Ar and C/36 Ar ratios; (4) the percentage of Martian degassing inferred by the model, and 5 and 6) the equivalent global column heights of liquid water and solid $CaCO_3$ over the entire surface of Mars that would be formed from the model quantities of degassed volatiles.
Author

**N89-18297*#** Pacha Runkhu Ltda., Bogota (Colombia).
**A MARINERIS VALLIS SAMPLE SITE Abstract Only**
C. S. Bridger *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 43 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Consideration is given to the choice of a Marineris Vallis canyon site in that it may offer the widest possible variety of martian units with a minimum amount of roving. Researchers support this in the classical comparison of Marineris Vallis with the Grand Canyon of the U.S.A. It is well-known to American geologists that most of the geological units in the U.S. may be found here in one section. Might not the Martian canyon offer a similar selection but only more so in view of its much greater size. A system whereby this sampling may be effected is proposed based on a combination of a skip with a wire-line core-barrel method. The final design will depend more on the completeness of the core to be taken as the entire section is that long that the weight of the core of the whole section may well be prohibitive for return to Earth unless several returns are envisaged. The wire-line is operated from a static head-gear in much the same way as an oil well implying a lander not needing mobility of any kind - a destinct advantage.
Author

**N89-18298*#** Wisconsin Univ., Madison. Dept. of Geology and Geophysics.
**FLUID INCLUSIONS IN MARTIAN SAMPLES: CLUES TO EARLY CRUSTAL DEVELOPMENT AND THE HYDROSPHERE**
Philip E. Brown *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 44-45 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Major questions about Mars that could be illuminated by examining fluid inclusions in Martian samples include: (1) the nature, extent and timing of development (and decline) of the hydrosphere that existed on the planet; and (2) the evolution of the crust. Fluid inclusion analyses of appropriate samples could provide critical data to use in comparison with data derived from analogous terrestrial studies. For this study, sample handling and return restrictions are unlikely to be as restrictive as the needs of other investigators. The main constraint is that the samples not be subjected to excessively high temperatures. An aqueous fluid inclusion trapped at elevated pressure and temperature will commonly consist of liquid water and water vapor at room temperature. Heating (such as is done in the laboratory to fix P-V-T data for the inclusion) results in moderate pressure increases up to the liquid-vapor homogenization temperature followed by a sharp increase in pressure with continued heating because the inclusion is effectively a fixed volume system. This increased pressure can rupture the inclusion; precise limits are dependent on size, shape, and composition as well as the host material.
Author

**N89-18299*#** Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences.
**SAMPLING THE OXIDATIVE WEATHERING PRODUCTS AND THE POTENTIALLY ACIDIC PERMAFROST ON MARS**
Roger G. Burns *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 46-47 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Large areas of Mars' surface are covered by oxidative weathering products containing ferric and sulfate ions having analogies to terrestrial gossans derived from sulfide mineralization associated with iron-rich basalts. Chemical weathering of such massive and disseminated pyrrhotite-pentlandite assemblages and host basaltic rocks in the Martian environment could have produced metastable gossaniferous phases (limonite containing poorly crystalline hydrated ferric sulfates and oxyhydroxides, clay silicates and opal). Underlying groundwater, now permafrost on Mars, may still be acidic due to incomplete buffering reactions by wall-rock alteration of unfractured host rock. Such acidic solutions stabilize temperature-sensitive complex ions and sols which flocculate to colloidal precipitates at elevated temperatures. Sampling procedures of Martian regolith will need to be designed bearing in mind that the frozen permafrost may be corrosive and be stabilizing unique complex ions and sols of Fe, Al, Mg, Ni and other minor elements.
Author

**N89-18300*#** Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences.
**SULFIDE MINERALIZATION: ITS ROLE IN CHEMICAL WEATHERING OF MARS**
Roger G. Burns *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 48-50 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Pyrrhotite-pentlandite assemblages in mafic and ultramafic igneous rocks may have contributed significantly to the chemical weathering reactions that produced degradation products in the Martian regolith. By analogy with terrestrial processes, a model is proposed whereby supergene alteration of these primary Fe-Ni sulfides on Mars has generated secondary sulfides (e.g., pyrite) below the water table and produced acidic groundwater containing high concentrations of dissolved Fe, Ni and sulfate ions. The low pH solutions also initiated weathering reactions of igneous feldspars and ferromagnesian silicates to form clay silicate and ferric oxyhydroxide phases. Near-surface oxidation and hydrolysis of ferric sulfato- and hydroxo-complex ions and sols formed gossans above the water table consisting of poorly crystalline hydrated ferric sulfates (e.g., jarosite), oxides (ferrihydrite, goethite) and silica (opal). Underlying groundwater, now permafrost, contains hydroxo sulfato complexes of Fe, Al, Mg, Ni, etc., which may be stabilized in frozen acidic solutions beneath the surface of Mars. Sublimation of permafrost may replenish colloidal ferric oxides, sulfates and phyllosilicates during dust storms on Mars.
Author

**N89-18301*#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**SURFACE COMPOSITIONAL AND STRUCTURAL ASPECTS OF MARTIAN SAMPLES**
D. A. Cadenhead *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 51-52 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

There are many excellent reasons to examine the surface composition of a wide range of Martian samples. The existing spectral data indicate that many dust and soil particles have a thin Fe(+3) layer with a typical particle size in the 10 micrometer to 400 micrometer range. In view of the high CO2 content of the atmosphere, one might expect that surface carbonates should be present. In addition to chemisorbed material there will probably exist physisorbed atmospheric components of the atmosphere including oxygen, nitrogen and water vapor. The latter could possibly give rise to some hydrated minerals. Using ultra-high-vacuum/mass spectrographic techniques it should be possible to detect physisorbed and moderately strong chemisorbed species on the particle surfaces with a temperature programmed degassing procedure. In some instances such an approach is capable of helping distinguish between volcanic and impact generated materials by detecting the presence of fumerolic gases. Such gases typically condense on the exterior of the ejected particles. Additionally surface atomic and chemical compositions should be examined by a combination of modern surface analytical techniques. The combination we currently have in Buffalo at SUNY would appear to be one of the best available including ESCA (150 micrometer spot capability) Auger (SAM) with 300 A focussing for surface compositional surveys, SIMS for high sensitivity trace element detection and ISS for immediate surface layer analysis.
Author

**N89-18302*#** Geological Survey, Menlo Park, CA.
**OVERVIEW OF MARS: VIKING RESULTS**
Michael H. Carr *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 53-54 (For primary

document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

As a result of the Viking orbiter observations, the entire surface of Mars has been imaged at a resolution of 200 meters, and fractions of the surface down to resolutions of 10 meters, the thermal inertia of the entire surface is known to a resolution of 30 km, and the water content of the atmosphere has been monitored over two Martian years. In addition, at two sites, the Viking landers analyzed the atmosphere, imaged the surface, performed organic and inorganic analyses on the soil, and monitored meteorological conditions for almost three Martian years. The results show that Mars is a highly variegated planet with a long and complex history of volcanic and tectonic activity, a surface that has been modified by wind, water and ice, and an atmosphere that has experienced substantial changes, both periodic and secular. The variety of processes that have operated on the surface, and the long history of their action, result in a much broader range of sampling problems and opportunities than was experienced in the case of the Moon.
Author

**N89-18303*#** Bromwell and Carrier, Inc., Lakeland, FL.
**SOIL MECHANICS ON THE MOON, MARS, AND MULBERRY**
W. D. Carrier, III *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 55-56 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

From a soil mechanics point of view, the Moon is a relatively simple place. Without any water, organics, or clay minerals, the geotechnical properties of the lunar soil are confined to a fairly limited range. Furthermore, the major soil-forming agent is meteorite impact, which breaks the big particles into little particles; and simultaneously, cements the little particles back together again with molten glass. After about a hundred million years of exposure to meteorite impact, the distribution of particle sizes in the soil achieves a sort of steady state. The majority of the returned lunar soil samples have been found to be well-graded silty-sand to sandy-silt (SM in the Unified Soil Classification System). Each of the particle size distributions plots within a relatively narrow band, which appears to be uniform over the entire lunar surface. This further restricts the range of physical properties of the lunar surface. In contrast, Martian soils should exhibit an extremely wide range of properties. We already know that there is a small amount of water in the soil, greater than in the Martian atmosphere. Furthermore, the soil is suspected to be smectitic clay. That makes two out of the three factors that greatly affect the properties of terrestrial soils.
Author

**N89-18304*#** National Museum of Natural Sciences, Madrid (Spain). Dept. of Geology.
**SAMPLING THE ANCIENT VOLATILE-RICH AREAS OF MARS**
A. F. Chicarro *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 57-58 (For primary document see N89-18288 10-91)
(Contract NASw-4066)
Avail: NTIS HC A09/MF A01 CSCL 03B

Viking images clearly show areas with a high density of fluidized craters that also display a significant number of wrinkle ridges. Fluidized crater ejecta morphology may indicate that the target material was rich in volatiles at the time of the impact. Therefore, these areas are of the utmost importance in deciphering both the Martian tectonic evolution and the amount of subsurface water, at times when more favorable conditions for life to evolve did exist on Mars. Although a large number of extensional features are associated with Tharsis and Elysium geologic activity, the planet-wide distribution of ridges suggests that Mars' tectonic history is far more complex than the Tharsis-dominated scenario indicates. Like on the Moon and Mercury, ridges on Mars were formed under compressive stresses, probably as a result of thrust-fault mechanism, although surface expressions and direct causes vary. Martian ridges are most easily seen on smooth plains of volcanic origin, but the majority of the 16,000 mapped and classified compressive features are located in the old terrains, far beyond Tharsis influence.
Author

**N89-18305*#** Grumman Aerospace Corp., Spring, TX.
**MARS SAMPLE RETURN MISSION: WHAT LEVEL OF COMPLEXITY** **c12**
Thomas M. Ciesla *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 59-60 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 22A

The complexity of the U.S. Sample Return Mission is ultimately dependent on current mission funding and the projected direction of the U.S. space program. Despite these uncertainties, it is important to examine mission scenarios to address desired scientific objectives that can be summarized in the following list: (1) determine existence of climatic records in geologic records; (2) does Mars have a subpermafrost groundwater system; (3) fundamental questions on the existence of Mars biology; (4) what is the internal structure of Mars; (5) determine the systems for regolith formation; and (6) what is the contribution of meteorites to Martian geology and climate are presented. To address these objectives, the sample size, quantity and location must be established and whether this should be the only data searched for on the Martian surface. With this in mind, three mission scenarios are briefly discussed, in order of increasing complexity.
Author

**N89-18306*#** Martin Marietta Aerospace, Denver, CO. Planetary Sciences Lab.
**MARTIAN REGOLITH GEOCHEMISTRY AND SAMPLING TECHNIQUES Abstract Only**
B. C. Clark *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 61 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Laboratory study of samples of the intermediate and fine-grained regolith, including duricrust peds, is a fundamental prerequisite for understanding the types of physical and chemical weathering processes on Mars. The extraordinary importance of such samples is their relevance to understanding past changes in climate, availability (and possible physical state) of water, eolian forces, the thermal and chemical influences of volcanic and impact processes, and the inventory and fates of Martian volatiles. Fortunately, this regolith material appears to be ubiquitous over the Martian surface, and should be available at many different landing sites. Viking data has been interpreted to indicate a smectite-rich regolith material, implying extensive weathering involving aqueous activity and geochemical alteration. An all-igneous source of the Martian fines has also been proposed. The X-ray fluorescence measurement data set can now be fully explained in terms of a simple two-component model. The first component is silicate, having strong geochemical similarities with Shergottites, but not other SNC meteorites. The second component is salt. Variations in these components could produce silicate and salt-rich beds, the latter being of high potential importance for microenvironments in which liquid water (brines) could exist. It therefore would be desirable to scan the surface of the regolith for such prospects.
Author

**N89-18307*#** Space Services Inc. of America, Bethesda, MD.
**LUNAR PLACEMENT OF MARS QUARANTINE FACILITY Abstract Only**
James E. Davidson and W. F. Mitchell (Lady Base One Corp., Friendswood, TX.) *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 62 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Advanced mission scenarios are currently being contemplated that would call for the retrieval of surface samples from Mars, from a comet, and from other places in the solar system. An important consideration for all of these sample return missions is quarantine. Quarantine facilities on the Moon offer unique advantages over other locations. The Moon offers gravity, distance, and vacuum. It is sufficiently near the Earth to allow rapid resupply and easy communication. It is sufficiently distant to lessen the psychological impact of a quarantine facility on Earth's human

inhabitants. Finally, the Moon is airless, and seems to be devoid of life. It is, therefore, more suited to contamination control efforts. Author

**N89-18308*#** State Univ. of New York, Albany. Dept. of Geological Sciences.
**GLASS: A SOURCE OF DATA LEADING TO CONSTRAINTS ON THE VOLCANIC, IMPACT, AND ATMOSPHERIC HISTORIES OF MARS Abstract Only**
J. W. Delano *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 63-64 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Volcanism and impact are important processes on Mars. Both mechanisms can produce glasses. Criteria exist for distinguishing between impact glasses and volcanic glasses. Owing to the single-phase nature of glass, tiny pieces (approximately 50-micrometer diameter) are as compositionally representative as larger pieces, in contrast to multi-phase crystalline samples, such as basalts. The thesis of this abstract is that glasses may be common in the Martian regolith and should be a high-priority sample owing to their combination of: (1) low representative mass, and (2) high content of information. Author

**N89-18309*#** California Univ., Los Angeles. Dept. of Earth and Space Sciences.
**THE ISOTOPIC AND CHEMICAL EVOLUTION OF PLANETS: MARS AS A MISSING LINK**
D. J. DePaolo *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 65-66 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The study of planetary bodies has advanced to a stage where it is possible to contemplate general models for the chemical and physical evolution of planetary interiors, which might be referred to as UMPES (Unified Models of Planetary Evolution and Structure). UMPES would be able to predict the internal evolution and structure of a planet given certain input parameters such as mass, distance from the sun, and a time scale for accretion. Such models are highly dependent on natural observations because the basic material properties of planetary interiors, and the processes that take place during the evolution of planets are imperfectly understood. The idea of UMPES was particularly unrealistic when the only information available was from the earth. However, advances have been made in the understanding of the general aspects of planetary evolution now that there is geochemical and petrological data available for the moon and for meteorites. Author

**N89-18310*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**SEARCH FOR MARTIAN FOSSIL COMMUNITIES: SCIENCE STRATEGIES, SEDIMENT SITES, AND SAMPLE HANDLING**
David J. DesMarais *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 67-68 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The strategy for locating and sampling possible fossilized Martian organisms benefits from our experience with fossil microbial ecosystems on Earth. Evidence of early life is typically preserved as stromatolites in carbonates and cherts, and as microfossils in cherts, carbonates and shales. Stromatolites, which are laminated flat or domal structures built by microbial communities, are very likely the oldest and most widespread relics of early life. These communities flourished in supratidal to subtidal coastal benthic environments, wherever sunlight was available and where incoming sediments were insufficient to bury the communities before they became established. A logical site for such communities on Mars might be those areas in an ancient lake bed which were furthest from sediment input, but were still sufficiently shallow to have received sunlight. Therefore, although some sites within Valles Marineris might have contained ponded water, the possibly abundant sediment inputs might have overwhelmed stromatolite-like communities. Localized depressions which acted as catchment basins for ancient branched valley systems might be superior sites. Perhaps such depressions received drainage which, because of the relatively modest water discharges implied for these streams, was relatively low in transported sediment. Multiple streams converging on a single basin might have been able to maintain a shallow water environment for extended periods of time. Author

**N89-18311*#** Arizona Univ., Tucson. Lunar and Planetary Lab.
**ACCRETION AND PRIMARY DIFFERENTIATION OF MARS**
Michael J. Drake *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 69-70 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

In collecting samples from Mars to address questions such as whether Mars accreted homogeneously or heterogeneously, how Mars segregated into a metallic core and silicate mantle, and whether Mars outgassed catastrophically coincident with accretion or more serenely on a longer timescale, we must be guided by our experience in addressing these questions for the Earth, Moon, and igneous meteorite parent bodies. A key measurement to be made on any sample returned from Mars is its oxygen isotopic composition. A single measurement will suffice to bind the SNC meteorites to Mars or demonstrate that they cannot be samples of that planet. A positive identification of Mars as the SNC parent planet will permit all that has been learned from the SNC meteorites to be applied to Mars with confidence. A negative result will perhaps be more exciting in forcing us to look for another object that has been geologically active in the recent past. If the oxygen isotopic composition of Earth and Mars are established to be distinct, accretion theory must provide for different compositions for two planets now separated by only 0.5 AU. Author

**N89-18312*#** Arizona State Univ., Tempe.
**PENETRATOR ROLE IN MARS SAMPLE STRATEGY**
William Boynton, Steve Dwornik, William Eckstrom, and David A. Roalstad (Ball Aerospace Systems Div., Boulder, CO.) *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 71-72 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The application of the penetrator to a Mars Return Sample Mission (MRSM) has direct advantages to meet science objectives and mission safety. Based on engineering data and work currently conducted at Ball Aerospace Systems Division, the concept of penetrators as scientific instruments is entirely practical. The primary utilization of a penetrator for MRSM would be to optimize the selection of the sample site location and to help in selection of the actual sample to be returned to Earth. It is recognized that the amount of sample to be returned is very limited, therefore the selection of the sample site is critical to the success of the mission. The following mission scenario is proposed. The site selection of a sample to be acquired will be performed by science working groups. A decision will be reached and a set of target priorities established based on data to give geochemical, geophysical and geological information. The first task of a penetrator will be to collect data at up to 4 to 6 possible landing sites. The penetrator can include geophysical, geochemical, geological and engineering instruments to confirm that scientific data requirements at that site will be met. This in situ near real-time data, collected prior to final targeting of the lander, will insure that the sample site is both scientifically valuable and also that it is reachable within limits of the capability of the lander. Author

**N89-18313*#** Chicago Univ., IL.
**IN SITU CHEMICAL ANALYSES OF EXTRATERRESTRIAL BODIES Abstract Only**
Thanasis E. Economou and Anthony L. Turkevich *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 73-74 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

One of the most important tasks on any sample return mission will have to be a quick sample characterization in order to guarantee

a variety of collected samples. An alpha particle instrument with alpha, proton and X-ray modes can provide a quick and almost complete chemical analysis of Mars samples. This instrument is based on three interactions of the alpha particles from a radioactive source with matter: elastic scattering of the alpha particles by nuclei (alpha mode), (alpha,p) nuclear reaction with some light elements (proton mode), and excitation of the atomic structure of atoms by alpha particles, leading to emission of characteristic X-rays of the lunar surface at three sites during the Surveyor mission of 1967 to 1968. Since then the instrument has been improved and miniaturized substantially. As shown in the past, the alpha particle instrument can operate under Martian conditions without any degradation in the performance. The alpha and proton modes can provide vital information about the light elements, while the X-ray mode with its ambient temperature X-ray detector will be useful for the heavier elements. The excitation of the atomic structure is provided by the same alpha radioactive source that is used by alpha and proton modes or by an auxiliary X-ray source that is selected to enhance the sensitivity to some important geochemical elements. Author

**N89-18314*#** San Jose State Univ., CA. Dept. of Chemistry.
**COSMOGENIC NUCLIDES IN THE MARTIAN SURFACE: CONSTRAINTS FOR SAMPLE RECOVERY AND TRANSPORT**
Peter A. J. Englert *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 75-76 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Stable and radioactive cosmogenic nuclides and radiation damage effects such as cosmic ray tracks can provide information on the surface history of Mars. A recent overview on developments in cosmogenic nuclide research for historical studies of predominantly extraterrestrial materials was published previously. The information content of cosmogenic nuclides and radiation damage effects produced in the Martian surface is based on the different ways of interaction of the primary galactic and solar cosmic radiation (GCR, SCR) and the secondary particle cascade. Generally the kind and extent of interactions as seen in the products depend on the following factors: (1) composition, energy and intensity of the primary SCR and GCR; (2) composition, energy and intensity of the GCR-induced cascade of secondary particles; (3) the target geometry, i.e., the spatial parameters of Martian surface features with respect to the primary radiation source; (4) the target chemistry, i.e., the chemical composition of the Martian surface at the sampling location down to the minor element level or lower; and (5) duration of the exposure. These factors are not independent of each other and have a major influence on sample taking strategies and techniques. Author

**N89-18315*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**METEORITES ON MARS**
G. J. Flynn (State Univ. of New York, Plattsburgh.) and D. S. McKay *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 77-78 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Four types of meteoritic material should be found on Mars: (1) micrometeorites, many of which will survive atmospheric entry unmelted, which should fall relatively uniformly over the planet's surface, (2) ablation products from larger meteorites which ablate, break up and burn up in the Mars atmosphere, (3) debris from large, crater forming objects, which, by analogy to terrestrial and lunar impact events, will be concentrated in the crater ejecta blankets (except for rare, large events, such as the proposed C-T event on earth, which can distribute debris on a planetary scale), and (4) debris from the early, intense bombardment, which, in many areas of the planet, may now be incorporated into rocks by geologic processes subsequent to the intense bombardment era. To estimate the extent of meteoritic addition to indigenous Martian material, the meteoritic flux on Mars must be known. It is estimated that the overall flux is twice that for the Moon and 1.33 that for Earth. For small particles, whose orbital evolution is dominated by Poynting Robertson drag, the flux at Mars can be estimated from the Earth flux. The smaller Martian gravitational enhancement as well as the decrease in the spatial density of interplanetary dust with increasing heliocentric distance should reduce the flux of small particles at Mars to about 0.33 times the flux at Earth. Because of the smaller planetary cross-section the total infalling mass at Mars is then estimated to be 0.09 time the infalling mass in the micrometeorite size range at Earth. Author

**N89-18316*#** Florida State Univ., Tallahassee. Dept. of Biological Science.
**TRACE FOSSILS OF MICROBIAL COLONIZATION ON MARS: CRITERIA FOR SEARCH AND FOR SAMPLE RETURN**
E. I. Friedmann *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 79-80 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The recent discovery of microbial trace-fossil formation in the frigid Ross Desert of Antarctica suggests that early primitive life on Mars may have left behind similar signatures. These trace fossils are apparent as chemical or physical changes in rock (or sediment) structure (or chemistry) caused by the activity of organisms. Life on Mars, if it ever existed, almost certainly did not evolve above the level of microorganisms, and this should be considered in search for fossil life. For the reasons detailed here, microbial trace fossils seem to be a better and more realistic target for search than would be true microbial fossils (remnants of cellular structures). Author

**N89-18317*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A MARS ORBITAL LASER ALTIMETER FOR ROVER TRAFFICABILITY: INSTRUMENT CONCEPT AND SCIENCE POTENTIAL** **c19**
J. B. Garvin and M. T. Zuber *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 81-82 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 14B

Limited information on the types of geologic hazards (boulders, troughs, craters etc.) that will affect rover trafficability on Mars are available for the two Viking Lander sites, and there are no prospects for increasing this knowledge base in the near future. None of the instrument payloads on the upcoming Mars Observer or Soviet PHOBOS missions can directly measure surface obstacles on the scales of concern for rover safety (a few meters). Candidate instruments for the Soviet Mars 92 orbiter/balloon/rover mission such as balloon-borne stereo imaging, rover panoramic imaging, and orbital synthetic aperature imaging (SAR) are under discussion, but data from this mission may not be available for target areas of interest for the U.S. Mars Rover Sample Return (MRSR) mission. In an effort to determine how to directly measure the topography of surface obstacles that could affect rover trafficability on Mars, we are studying how to design a laser altimeter with extremely high spatial and vertical resolution that would be suitable for a future Mars Orbiter spacecraft (MRSR precursor or MRSR orbiter). This report discusses some of the design issues associated with such an instrument, gives examples of laser altimeter data collected for Mars analog terrains on Earth, and outlines the scientific potential of data that could be obtained with the system. Author

**N89-18318*#** Missouri Univ., Columbia.
**THE SEARCH FOR AN IDENTIFICATION OF AMINO ACIDS, NUCLEOBASES AND NUCLEOSIDES IN SAMPLES RETURNED FROM MARS**
Charles W. Gehrke, Cyril Ponnamperuma, Kenneth C. Kuo, David L. Stalling (Interior Dept., Columbia, MO.), and Robert W. Zumwalt *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 83-85 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The Mars Sample Return mission will provide us with a unique source of material from our solar system; material which could advance our knowledge of the processes of chemical evolution.

As has been pointed out, Mars geological investigations based on the Viking datasets have shown that primordial Mars was in many biologically important ways similar to the primordial Earth; the presence of surface liquid water, moderate surface temperatures, and atmosphere of carbon dioxide and nitrogen, and high geothermal heat flow. Indeed, it would seem that conditions on Earth and Mars were fundamentally similar during the first one billion years or so. As has been pointed out, Mars may well contain the best preserved record of the events that transpired on the early planets. Examination of that early record will involve searching for many things, from microfossils to isotopic abundance data. We propose an investigation of the returned Mars samples for biologically important organic compounds, with emphases on amino acids, the purine and pyrimidine bases, and nucleosides. Author

**N89-18319*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**SOIL DEVELOPMENT AND SAMPLING STRATEGIES FOR THE RETURNED MARTIAN SURFACE SAMPLES** **c25**
Everett K. Gibson *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 86-87 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

Sampling of the Martian surface materials should be based on the experience gained from the study of soils and rocks collected in cold, dry environments, i.e., dry valleys of Antarctica. Previous studies have suggested that some of our best terrestrial analogs of the Martian soils are represented by those found in the polar deserts of Antarctica. Special sampling considerations must be taken into account when obtaining these samples because they represent at least five distinct types of materials. Weathering of planetary regolith materials occurs from both chemical and physical interactions of the planet's surface materials with the atmosphere and, if present, the hydrosphere and biosphere along with extraplanetary objects which may produce the original surface materials and produce secondary materials that are product of equilibrium between the atmosphere and study weathering processes and regolith development occurring on Martian-like surfaces, simulation studies must be carried out in materials in the field. Author

**N89-18320*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**MARTIAN WEATHERING PRODUCTS AS TRACERS OF CLIMATE CHANGE AND ATMOSPHERE/HYDROSPHERE EVOLUTION ON MARS**
J. L. Gooding *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 88-89 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Primary objectives for exploration of Mars include determination of: (1) the distribution, abundance, and sources and sinks of volatile materials, and (2) the interaction of surface materials with the atmosphere. Both objectives fall within the purview of planetary surface weathering studies and require documented samples of weathered materials, including rock surfaces, soils, and sediments. Major issues to be addressed in selecting and studying Martian samples in this context are summarized. Author

**N89-18321*#** European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands). Dept. of Space Science.
**AN INSTRUMENT FOR MEASURING THE COMPLEX PERMITTIVITY OF THE MARTIAN TOP SOIL** **c35**
R. Grard *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 90-91 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 14B

This permittivity measuring instrument measures the resistivity rho and the relative dielectric constant epsilon sub r of the Martian top soil along the path of a rover. This aim is achieved by measuring the real and imaginary parts of the complex permittivity epsilon = epsilon sub r - j epsilon sub i where epsilon sub i = omega epsilon sub o rho/1; epsilon sub 1 is the permittivity of vacuum and omega is a variable angular working frequency. The experimental technique consists in evaluating the mutual, or transfer, impedance of a quadrupolar probe, i.e., in quantifying the influence of the Martian ground on the electrical coupling of two Hertz dipoles. The horizontal and vertical spatial resolutions are of the order of the length and separation of the dipoles, typically 1 to 2 metres. The four-electrode method for measuring the ground resistivity on earth was first applied by Wenner and Schlumberger, but the proposed investigation bears closer resemblance to a similar instrument developed for ground surveying at shallow depth, in connection with archaelogical and pedological research. A quadrupolar probe will provide essential information about the electric properties of the Martian ground and will contribute usefully to the identification of the soil structure and composition in association with other experimental equipment (camera, infra-red detector, gamma and X-ray spectrometers, chemical analyzers, ground temperature probes). Author

**N89-18322*#** Arizona State Univ., Tempe. Dept. of Geology.
**MARS SAMPLING STRATEGY AND AEOLIAN PROCESSES**
Ronald Greeley *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 92-93 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

It is critical that the geological context of planetary samples (both in situ analyses and return samples) be well known and documented. Apollo experience showed that this goal is often difficult to achieve even for a planet on which surficial processes are relatively restricted. On Mars, the variety of present and past surface processes is much greater than on the Moon and establishing the geological context of samples will be much more difficult. In addition to impact hardening, Mars has been modified by running water, periglacial activity, wind, and other processes, all of which have the potential for profoundly affecting the geological integrity of potential samples. Aeolian, or wind, processes are ubiquitous on Mars. In the absence of liquid water on the surface, aeolian activity dominates the present surface as documented by frequent dust storms (both local and global), landforms such as dunes, and variable features, i.e., albedo patterns which change their size, shape, and position with time in response to the wind. Author

**N89-18323*#** Arizona State Univ., Tempe. Dept. of Chemistry.
**PETROLOGIC CONSTRAINTS ON THE PRESSURE, TEMPERATURE, TIME AND COMPOSITION OF THE MARTIAN INTERIOR**
John R. Holloway *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 95-96 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Petrologic analysis of surface samples has been used to deduce pressure and temperature conditions existing in the crust and upper mantle at specific times in the Earth's history, as well as to estimate the chemical and mineralogical composition of the crust and upper mantle. The same techniques can be applied to samples of the Martian surface to provide P, T, time and composition constraints of the Martian interior. Estimates of P and T conditions existing at a given time would, in turn, provide strong constraints on the thermal evolution of Mars. Knowledge of the chemical and mineralogical composition of the Martian interior is of fundamental importance in assessing the early history of the solar system. A general petrological approach is outlined, describing the kinds of sample required, summarizing current understanding of the Martian interior based on experimental petrology, and outlining some of the important experiments needed to allow a full petrologic interpretation of Martian samples. Author

**N89-18324*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**SPECULATIONS ON THE IGNEOUS HISTORY OF MARS: INFERENCES FROM THE SNC METEORITES**

John H. Jones *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 97-98 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

In general, attempts to delineate an a priori sampling strategy for missions to terrestrial planets must be simple. In the case of the Moon, for example, the simplest and most obvious plan that to sample both the highly-cratered, high-albedo highlands and less-cratered, low-albedo mare--has proven very useful. However in the case of Mars, multiple missions and/or roving samplers may prove expensive or infeasible. Thus, we may be limited to collecting samples from a single site, and, consequently, consideration of sampling strategies for a Mars mission is more critical than for the more-accessible Moon. Author

**N89-18325*#** Houston Univ., TX. Dept. of Geosciences.
**HELLAS BASIN EJECTA: A PRIME STRATIGRAPHIC MARKER AND SAMPLING TARGET Abstract Only**
Elbert A. King *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 99 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The Hellas Basin and associated ejecta deposits dominate a large portion of the southern highlands of Mars. These deposits have been particularly well-documented at the scale 1:5,000,000 in the Sinus Sabaeus (MC-20), Iapygia (MC-21) and Mare Tyrrhenum (MC-22) quadrangles (1,2,3) where they have been mapped as ancient hilly and cratered material. In MC-22 the ejecta deposit is interpreted to thin from west to east, away from Hellas. In the eastern part of MC-22, the outlines of some large older craters, such as Hershel, can be seen through the thin ejecta cover and some of these buried craters even have enough relief to act as depositional traps for later mostly eolian sediments. Superposed on the ejecta is a population of numerous intermediate-sized to smaller craters which indicates the relatively old age of the ejecta deposit and causes the unit to have rather rough surface topography. Numerous small channels on steeply sloping crater rims and regionally sloping surface indicate erosion, transportation and redeposition of substantial amounts of ejecta materials, probably by aqueous fluvial processes. Numerous more recent volcanic constructs and flows also are superposed on the ejecta. Author

**N89-18326*#** Santa Clara Univ., CA. Dept. of Biology.
**CONTINUING THE BIOLOGICAL EXPLORATION OF MARS**
Harold P. Klein *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 100-101 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Mars has been an object of interest for the better part of this century. To a biologist, Mars assumes special importance because many aspects of the theory of chemical evolution for the origin of life can be tested there. The central idea of this theory is that life on a suitable planet arises through a process in which the so-called biogenic elements combine to form increasingly more complex molecules under the influence of naturally-occurring energy sources ultimately resulting in the formation of replicating organic molecules. The biogenic elements are present on Mars today. Furthermore, the available evidence also strongly suggests that Mars may have had an early history similar to that of the Earth, including a period in which large amounts of liquid water once flowed on its surface and a denser atmosphere and higher global temperatures prevailed. This is important since many lines of evidence indicate that living organisms were already present on the Earth within the first billion years after its formation at a time when the environment on Mars may have closely resembled that of Earth. Our current knowledge of the state of chemical evolution on Mars can best be described as paradoxical. Most of what we have learned has come from experiments performed on the Viking landers. The combination of planned investigations covered a broad range of techniques to detect signs of chemical evolution. The most surprising data from all of these was the absence of any detectable quantities of organic compounds at the two landing sites. On the other hand, the Viking experiments did indicate that the Martian surface samples contained unidentified strong oxidant(s) that could account for their absence. Author

**N89-18327*#** Wien Univ. (Austria). Inst. of Geochemistry.
**SAMPLING MARS: ANALYTICAL REQUIREMENTS AND WORK TO DO IN ADVANCE**
Christian Koeberl *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 102-103 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Sending a mission to Mars to collect samples and return them to the Earth for analysis is without doubt one of the most exciting and important tasks for planetary science in the near future. Many scientifically important questions are associated with the knowledge of the composition and structure of Martian samples. Amongst the most exciting questions is the clarification of the SNC problem- to prove or disprove a possible Martian origin of these meteorites. Since SNC meteorites have been used to infer the chemistry of the planet Mars, and its evolution (including the accretion history), it would be important to know if the whole story is true. But before addressing possible scientific results, we have to deal with the analytical requirements, and with possible pre-return work. It is unlikely to expect that a possible Mars sample return mission will bring back anything close to the amount returned by the Apollo missions. It will be more like the amount returned by the Luna missions, or at least in that order of magnitude. This requires very careful sample selection, and very precise analytical techniques. These techniques should be able to use minimal sample sizes and on the other hand optimize the scientific output. The possibility to work with extremely small samples should not obstruct another problem: possible sampling errors. As we know from terrestrial geochemical studies, sampling procedures are quite complicated and elaborate to ensure avoiding sampling errors. The significance of analyzing a milligram or submilligram sized sample and putting that in relationship with the genesis of whole planetary crusts has to be viewed with care. This leaves a dilemma on one hand, to minimize the sample size as far as possible in order to have the possibility of returning as many different samples as possible, and on the other hand to take a sample large enough to be representative. Whole rock samples are very useful, but should not exceed the 20 to 50 g range, except in cases of extreme inhomogeneity, because for larger samples the information tends to become redundant. Soil samples should be in the 2 to 10 g range, permitting the splitting of the returned samples for studies in different laboratories with variety of techniques.
Author

**N89-18328*#** Washington Univ., St. Louis, MO. Dept. of Earth and Planetary Sciences.
**SOME LESSONS FROM APOLLO FOR A SAMPLING STRATEGY ON MARS FOR UNDERSTANDING THE ORIGIN OF THE ANCIENT IGNEOUS CRUST AND THE COMPOSITION OF THE MANTLE**
Randy L. Korotev and Larry A. Haskin *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 104-105 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Proper site selection for sample collection is crucial to determining the nature and time scales of major events on Mars. Analysis and interpretation of lunar samples acquired by the Apollo lunar missions provides valuable experience on the effects of site selection. Lunar selection techniques are briefly examined. B.G.

**N89-18329*#** Geological Survey, Reston, VA.
**ORGANIC AND INORGANIC GEOCHEMISTRY OF SAMPLES RETURNED FROM MARS** **c25**
R. K. Kotra and R. G. Johnson *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 106-107 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

Although a tremendous amount of knowledge can be obtained

by in situ experiments on Mars, greater benefits will be realized with the sample return mission from the perspective of exobiology. Sampling techniques are briefly discussed. B.G.

**N89-18330*#** Academy of Sciences (USSR), Moscow. Inst. of Geochemistry and Analytical Chemistry.
**THE STRUCTURE OF THE MARTIAN CRYOLITHOSPHERE UPPER LEVELS Abstract Only c25**
R. O. Kuzmin, N. N. Bobina, E. V. Zabalueva, and V. P. Shashkina *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 108 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

Structural inhomogeneities of the Martian cryolithosphere upper levels were studied by the proposed crater method. On the basis of analysis of 127 photomaps of 1:2 million scale morphological and morphometrical parameters of all the fresh craters larger than 1 km in diameter with fluidized ejecta and without it were investigated. Using the parameters of the craters, the roof depths of ice-bearing rocks were estimated and the data on the ice relative constant in the excavated permafrost layer were obtained. These data were used for the construction of maps of the boundary depth between ice-free nearsurface layer and ice-bearing rocks. A series of maps of the relative ice content for individual permafrost horizons was constructed. It was deduced from the obtained maps that the zone of the dryest nearsurface rocks on Mars is in the latitude belt + or - 30 degrees where maximum floor depths of the ice-bearing rocks vary from 400 to more than 400 m. It was found that the thickness of ice-free rocks in the Southern Hemisphere is larger than in the Northern one. The tendency of similarity of latitudinal zonality observed both on the maps of the minimal and mean roof depths may be considered as an indicator of structural stability of upper horizons of the Martian cryolithosphere down to the depths of 300 to 400 m. The areas of minimal ice content in the nearsurface layers coincide with the zone of maximum thickness of ice-free rocks. The ice relative content in Martian rocks becomes systematically higher from 30 deg latitude to the polars. The same tendency is observed in depth. The data obtained may be useful for the selecting of landing sites for Mars samples return and other missions. Author

**N89-18331*#** Biospherics, Inc., Rockville, MD.
**THE LIFE ON MARS DILEMMA AND THE SAMPLE RETURN MISSION**
Gilbert V. Levin *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 209-110 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The dilemma of whether there is life on Mars impacts on the method used for sampling. The NASA Mars Sample Return Mission should be used to resolve the problems. B.G.

**N89-18332*#** Purdue Univ., West Lafayette, IN. Dept. of Chemistry.
**VOLATILE/MOBILE TRACE ELEMENTS IN METEORITIC, NON-LUNAR BASALTS: GUIDES TO MARTIAN SAMPLE CONTENTS Abstract Only**
M. E. Lipschutz and R. L. Paul *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 111-112 (For primary document see N89-18288 10-91)
(Grants NAG9-48; NSF DPP-84-15061)
Avail: NTIS HC A09/MF A01 CSCL 03B

A variety of genetic processes on or in extraterrestrial objects can be examined by study of volatile/mobile trace elements. Doubtless, considerable efforts will be expended on determining these elements in returned Martian samples. The purpose is to estimate levels of such elements expected to be present in returned Martian samples. Some ideas about Martian genesis were already advanced from the volatile/mobile element contents in SNC meteorites, assuming that Mars was their parent body. Even is Mars and the SNC meteorite parent body are identical, compositional ranges for returned Martian samples should exceed those of SNC meteorites. It is expected, therefore, that Martian samples returned from locations other than Polar regions will have indigenous volatile/mobile element contents within howardite-diogenite ranges. Elements with strong lithophile tendences may be more abundant, as they are in many lunar samples. Most of these elements should be at ppb levels except for Co, Ga, Zn, and Rb, which should lie at ppm levels. If Martian volcanism was accompanied by fumarolic emanations, it should be reflected in occasional huge enrichments of mobile trance elements, as in lunar meteorite Y 791197. During collection and transport Earthward, samples must be contained under conditions appropriate to ppb concentrations. Materials must be used that will not cause contamination which occurred during the Apollo program, where indium from seals contaminated many samples. Author

**N89-18333*#** Geological Survey, Flagstaff, AZ.
**VALLES MARINERIS, MARS: AN OPTIMUM SCIENCE-SAMPLE SITE**
B. K. Lucchitta *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 113-114 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The Valles Marineris troughs offer an opportunity to sample rocks that reflect various ages and compositions, giving insight into important processes on Mars. Most of the samples would be located within reasonable proximity and could be easily reached by rovers or balloons. Although landing a spacecraft on the floor of the Valles Marineris may be too dangerous for the first sample-return mission to Mars, the scientific rewards would be so great that such a landing should be considered for later flights. Author

**N89-18334*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**EXOBIOLOGY AND THE SEARCH FOR BIOLOGICAL SIGNATURES ON MARS**
Rocco L. Mancinelli and Deborah E. Schwartz *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 115-116 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

In preparation for a Mars Rover/Sample return mission, the mission goals and objectives must be identified. One of the most important objectives must address exobiology and the question of the possibility of the origin and evolution of life on Mars. In particular, key signatures or bio-markers of a possible extinct Martian biota must be defined. To that end geographic locations (sites) that are likely to contain traces of past life must also be identified. Sites and experiments are being defined in support of a Mars rover sample return mission. In addition, analyses based on computer models of abiotic processes of CO2 loss from Mars suggest that the CO2 from the atmosphere may have precipitated as carbonates and be buried within the Martian regolith. The carbon cycle of perennially frozen lakes in the dry valley of Antarctica are currently being investigated. These lakes were purported to be a model system for the ancient Martian lakes. By understanding the dynamic balance between the abiotic vs. biotic cycling of carbon within this system, information is gathered which will enable the interpretation of data obtained by a Mars rover with respect to possible carbonate deposits and the processing of carbon by biological systems. These ancient carbonate deposits, and other sedimentary units would contain traces of biological signatures that would hold the key to understanding the origin and evolution of life on Mars, as well as Earth. Author

**N89-18335*#** Department of Environmental Regulation, Tampa, FL.
**MARTIAN SEDIMENTS AND SEDIMENTARY ROCKS**
C. D. Markun *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 117-118 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Martian sediments and sedimentary rocks, clastic and

nonclastic, should represent a high priority target in any future return-sample mission. The discovery of such materials and their subsequent analysis in terrestrial laboratories, would greatly increase the understanding of the Martian paleoclimate. The formation of Martian clastic sedimentary rocks, under either present, low-pressure, xeric conditions or a postulated, high-pressure, hydric environment, depends upon the existence of a supply of particles, various cementing agents and depositional basins. A very high resolution (mm-cm range) photographic reconnaissance of these areas would produce a quantum jump in the understanding of Martian geological history. Sampling would be confined to more horizontal (recent) surfaces. Exploration techniques are suggested for various hypothetical Martian sedimentary rocks. Author

**N89-18336*#** Geological Survey, Flagstaff, AZ.
**SEARCH FOR MARS LANDER/ROVER/SAMPLE-RETURN SITES: A STATUS REVIEW**
Harold Masursky, A. L. Dial, Jr., E. C. Morris, M. E. Strobell, D. J. Applebee, and M. G. Chapman *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 119-120 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Ten Mars sites were studied in the USA for four years. The sites are the Chasma Boreale (North Pole), Planum Australe (South Pole), Olympus Rupes, Mangala Valles, Memnonia Sulci, Candor Chasma, Kasei Valles, Nilosyrtis Mensae, Elysium Montes, and Apollinaris Patera. Seven sites are being studied by the USSR; their prime sites are located at the east mouth of Kasei Valles and near Uranius Patera. Thirteen geological maps of the first six USA sites are compiled and in review. Maps of the Mangala East and West sites at 1:1/2 million scale and a 1:2 million scale map show evidence of three episodes of small-channel formation interspersed with episodes of volcanism and tectonism that span the period from 3.5 to 0.6 b.y. ago. The tectonic and geological history of Mars, both ancient and modern, can be elucidated by sampling volcanic and fluvial geologic units at equatorial sites and layered deposits at polar sites. The evidence appears clear for multiple episodes of fluvial channeling, including some that are quite recent; this evidence contrasts with the theses of Baker and Partridge (1986) and many others that all channels are ancient. Verification of this hypothesis by Mars Observer will be an important step forward in the perception of the history of Mars. Author

**N89-18337*#** Arizona Univ., Tucson. Lunar and Planetary Lab.
**EARTH ROCKS ON MARS: MUST PLANETARY QUARANTINE BE RETHOUGHT**
H. J. Melosh *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 121-123 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Recent geochemical, isotopic, and rare gas studies suggest that eight SNC meteorites originated on the planet Mars. Since Martian rocks are found on Earth, consideration is being given to finding Earth rocks on Mars. Detailed consideration of the mechanism by which these meteorites were lofted into space strongly suggest that the process of stress-wave spallation near a large impact with, perhaps, an assist from vapor plume expansion, is the fundamental process by which lightly-shocked rock debris is ejected into interplanetary space. The theory of spall ejection was used to examine the mass and velocity of material ejected from the near vicinity of an impact. It seems likely that the half-dozen largest impact events on Earth would have ejected considerable masses of near surface rocks into interplanetary space. No computations were performed to indicate how long Earth ejecta would take to reach Mars. Author

**N89-18338*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ZEOLITES ON MARS: POSSIBLE ENVIRONMENTAL INDICATORS IN SOILS AND SEDIMENTS**
D. W. Ming and J. L. Gooding *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 124-125 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Weathering products should serve as indicators of weathering environments and may provide the best evidence of the nature of climate change on Mars. No direct mineralogical measurements of Martian regolith were performed by the Viking missions, but the biology and X-ray fluorescence experiments provided some information on the physiochemical properties of Martian regolith. Most post-Viking studies of candidate weathering products have emphasized phyllosilicates and Fe-oxides; zeolites are potentially important, but overlooked, candidate Martian minerals. Zeolites would be important on Mars for three different reasons. First, they are major sinks of atmospheric gases and, per unit mass, are stronger and more efficient sorbents than are phyllosilicates. Secondly, they can be virtually unique sorbents and shelters for organic compounds and possible catalysts for organic-based reactions. Finally, their exchangeable ions are good indicators of the chemical properties of solutions with which they have communicated. Accordingly, the search for information on past compositions of the Martian atmosphere and hydrosphere should find zeolites to be rich repositories. Author

**N89-18339*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**WHAT FERRIC OXIDE/OXYHYDROXIDE PHASES ARE PRESENT ON MARS**
Richard V. Morris *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 126-127 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The weathering history of Mars can be deduced largely from the mineralogy and distribution of ferric oxide/oxyhydroxide phases. As discussed, some insights can be gained through spectrophotometric remote sensing, but absolute determinations must depend on direct laboratory analysis of returned Martian samples. Author

**N89-18340*#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. for Optoelectronics.
**ABSOLUTE AGES FROM CRATER STATISTICS: USING RADIOMETRIC AGES OF MARTIAN SAMPLES FOR DETERMINING THE MARTIAN CRATERING CHRONOLOGY**
G. Neukum *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 128-129 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

In the absence of dates derived from rock samples, impact crater frequencies are commonly used to date Martian surface units. All models for absolute dating rely on the lunar cratering chronology and on the validity of its extrapolation to Martian conditions. Starting from somewhat different lunar chronologies, rather different Martian cratering chronologies are found in the literature. Currently favored models are compared. The differences at old ages are significant, the differences at younger ages are considerable and give absolute ages for the same crater frequencies as different as a factor of 3. The total uncertainty could be much higher, though, since the ratio of lunar to Martian cratering rate which is of basic importance in the models is believed to be known no better than within a factor of 2. Thus, it is of crucial importance for understanding the the evolution of Mars and determining the sequence of events to establish an unambiguous Martian cratering chronology from crater statistics in combination with clean radiometric ages of returned Martian samples. For the dating goal, rocks should be as pristine as possible from a geologically simple area with a one-stage emplacement history of the local formation. A minimum of at least one highland site for old ages, two intermediate-aged sites, and one very young site is needed. Author

**N89-18341*#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. for Optoelectronics.

**IN SITU MINERALOGICAL-CHEMICAL ANALYSIS OF MARTIAN MATERIALS AT LANDING/ROVING SITES BY ACTIVE AND PASSIVE REMOTE SENSING METHODS**

G. Neukum, F. Lehmann, P. Regner, and R. Jaumann *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 130-131 (For primary document see N89-18288 10-91)

Avail: NTIS HC A09/MF A01 CSCL 03B

Remote sensing of the Martian surface from the ground and from orbiting spacecraft has provided some first-order insight into the mineralogical-chemical composition and the weathering state of Martian surface materials. Much more detailed information can be gathered from performing such measurements in situ at the landing sites or from a rover in combination with analogous measurements from orbit. Measurements in the wavelength range of approximately 0.3 to 12.0 micrometers appear to be suitable to characterize much of the physical, mineralogical, petrological, and chemical properties of Martian surface materials and the weathering and other alteration processes that have acted on them. It is of particular importance to carry out measurements at the same time over a broad wavelength range since the reflectance signatures are caused by different effects and hence give different and complementing information. It appears particularly useful to employ a combination of active and passive methods because the use of active laser spectroscopy allows the obtaining of specific information on thermal infrared reflectance of surface materials. It seems to be evident that a spectrometric survey of Martian materials has to be focused on the analysis of altered and fresh mafic materials and rocks, water-bearing silicates, and possibly carbonates. Author

**N89-18342*#** New Mexico Univ., Albuquerque. Dept. of Geology.

**SAMPLES FROM MARTIAN CRATERS: ORIGIN OF THE MARTIAN SOIL BY HYDROTHERMAL ALTERATION OF IMPACT MELT DEPOSITS AND ATMOSPHERIC INTERACTIONS WITH EJECTA DURING CRATER FORMATION**

Horton E. Newsom *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 132-133 (For primary document see N89-18288 10-91)

Avail: NTIS HC A09/MF A01 CSCL 03B

The origin of the Martian soil is an important question for understanding weathering processes on the Martian surface, and also for understanding the global geochemistry of Mars. Chemical analyses of the soil will provide an opportunity to examine what may be a crustal average, as studies of loess on the Earth have demonstrated. In this regard the origin of the Martian soil is also important for understanding the chemical fractionations that have affected the composition of the soil. Several processes that are likely to contribute to the Martian soil are examined. Author

**N89-18343*#** Houston Univ., TX. Dept. of Biochemical and Biophysical Sciences.

**MARTIAN OXIDATION PROCESSES AND SELECTION OF ANCIENT SEDIMENTARY SAMPLES FOR BIO-ORGANIC ANALYSIS**

J. Oro *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 134-135 (For primary document see N89-18288 10-91)

Avail: NTIS HC A09/MF A01 CSCL 03B

The results obtained by the Viking Missions concerning organic and biological analysis are summarized and it is indicated that these results do not preclude the existence in buried or protected regions of the planet, organic molecules or fossil life. The use of automated instruments is suggested for the analyses of samples obtained from certain regions of the planet, as a preliminary step before they are selected, retrieved, and returned to Earth for more complete analysis. Author

**N89-18344*#** California Univ., Los Angeles.

**DECIPHERING MARTIAN CLIMATIC HISTORY USING RETURNED SAMPLES**

D. A. Paige, D. B. Krieger, and C. A. Brigham (California Inst. of Tech., Pasadena.) *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 136-137 (For primary document see N89-18288 10-91)

Avail: NTIS HC A09/MF A01 CSCL 03B

By necessity, a Mars sample return mission must sample the upper few meters of the Martian surface. This material was subjected to a wide variety of physical processes. Presently, the most important processes are believed to be wind-driven erosion and deposition, and water ice accumulation at higher latitudes. A sample return mission represents an opportunity to better understand and quantify these important geological processes. By obtaining sample cores at key locations, it may be possible to interpret much of recent Martian climatic history. Author

**N89-18345*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**CONDITIONS OF THE MARTIAN ATMOSPHERE AND SURFACE IN THE REMOTE PAST AND THEIR RELEVANCE TO THE QUESTION OF LIFE ON MARS**

Kevin D. Pang and Fun-Dow Tsay *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 138-139 (For primary document see N89-18288 10-91)

Avail: NTIS HC A09/MF A01 CSCL 03B

Although the Viking Landers failed to find any evidence of life on the surface of Mars, much remains unknown. Study of returned samples can answer some of these questions. The search for organic compounds, the building blocks of life forms based on carbon chemistry, should continue. The question of life on Mars is still an open one, and deserves to be addressed by the study of returned samples. Whether life developed and evolved on Mars or not depends critically on the history of the Martian atmosphere and hydrosphere. The exobiology of Mars is thus inextricably intertwined with the nature of its paleoatmosphere and the ancient state of the planet's regolith, which may still be preserved in the polar caps and underground. Core samples from such sites could answer some of the questions. Author

**N89-18346*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**CLIMATE, ATMOSPHERE, AND VOLATILE INVENTORY EVOLUTION: POLAR PROCESSES, CLIMATE RECORDS, VOLATILE INVENTORIES Abstract Only**

J. B. Pollack *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 140 (For primary document see N89-18288 10-91)

Avail: NTIS HC A09/MF A01 CSCL 03B

Climate change on Mars was driven by long term changes in the solar luminosity, variations in the partitioning of volatiles between the atmosphere and near-surface reservoirs, and astronomical variations in axial and orbital properties. There are important parallels between these drives for Mars and comparable ones for Earth. In the early history of the solar system, the Sun's luminosity was 25 to 30 percent lower than its current value. It is suggested that an early benign climate on Earth was due to the presence of much more carbon dioxide in its atmosphere at these early times than currently resides there. Such a partitioning of carbon dioxide, at the expense of the carbonate rock reservoir, may have resulted from a more vigorous tectonic and volcanic style at early times. Such a line of reasoning may imply that much more carbon dioxide was present in the Martian atmosphere during the planet's early history than resides there today. It is now widely recognized that astronomical variations of the Earth's axial and orbital characteristics have played a dominant role in causing the succession of glacial and interglacial periods characterizing the last several million years. The magnitude of the axial and eccentricity variations are much larger for Mars than for Earth. Such changes on Mars could result in sizeable variations in atmospheric pressure, dust storm activity, and the stability of perennial carbon dioxide and water ice polar caps. These

quasi-periodic climate changes occur on periods of 100,000 to 1,000,000 years and may be recorded in the sedimentary layers of the polar layered terrain. Author

**N89-18347*#** Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences.
**CHEMICAL INTERACTIONS BETWEEN THE PRESENT-DAY MARTIAN ATMOSPHERE AND SURFACE MINERALS: IMPLICATIONS FOR SAMPLE RETURN Abstract Only**
Ronald Prinn and Bruce Fegley *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 141 Previously announced as N88-29689 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Thermochemical and photochemical reactions between surface minerals and present-day atmospheric constituents are predicted to produce microscopic effects on the surface of mineral grains. Relevant reactions hypothesized in the literature include conversions of silicates and volcanic glasses to clay minerals, conversion of ferrous to ferric compounds, and formation of carbonates, nitrates, and sulfates. These types of surface-atmosphere weathering of minerals, biological potential of the surface environment, and atmospheric stability in both present and past Martian epochs. It is emphasized that the product of these reactions will be observable and interpretable on the microscopic surface layers of Martian surface rocks using modern techniques with obvious implications for sample return from Mars. Macroscopic products of chemical weathering reactions in past Martian epochs are also expected in Martian surface materials. These products are expected not only as a result of reactions similar to those proceeding today but also due to aqueous reactions in past epochs in which liquid water was putatively present. It may prove very difficult or impossible, however, to determine definitively from the relic macroscopic product alone either the exact weathering process which led to its formation of the identity of its weathering parent mineral. The enormous advantages of studying the Martian chemical weathering by investigating the microscopic products of present-day chemical reactions on sample surfaces are very apparent. Author

**N89-18348*#** Osmania Univ., Hyderabad (India). Dept. of Geology.
**DEGASSING HISTORY OF MARS FROM MARTIAN ATMOSPHERE SAMPLES Abstract Only** **c25**
A. S. P. Rao *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 142 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

A comparison of the abundances of Ar-40 and He-4 (radiogenic) in various terrestrial planetary atmospheres provides clues to the volcanic and tectonic histories of the planets while the amount of primordial noble gases in the planetary atmospheres provides clues to the quantities of volatile rich materials captured by each planet. The noble gas contents of Mars, Earth, and Venus clearly show that the absolute abundances of isotopes of gases are directly proportional to the amounts of degassed CO2 into the planetary atmosphere. Several basic geological units can be seen on the global geological map of Mars. The enormous size of volcanic and tectonic structures of Mars, despite its smaller size, provide invaluable clues to the degassing history of Mars. Therefore, the collection of samples of Martian atmosphere and soil volatiles is imperative to understand the origin and evolution of the atmosphere and its interaction with the Martian surface. Surface properties of Martian rocks, soils, breccias, and regolith and their chemistry are also generic to any discussion on the origin and evolution of the atmosphere of Mars. The differences in absolute abundances of gases in the planetary atmospheres are amenable to many alternative interpretations. These alternative interpretations can be tested by imposing additional constraints derived from the isotopic results of noble gases in the atmospheres of the planets.
Author

**N89-18349*#** Los Alamos National Lab., NM. Earth and Space Sciences Div.
**COSMOGENIC NUCLIDES: OBSERVABLE EFFECTS OF MARTIAN VOLATILES**
R. C. Reedy, D. M. Drake, and W. C. Feldman *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 143-144 Sponsored in part by NASA and DOE (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Cosmic-ray produced (cosmogenic) nuclides in returned Martian samples could be used to study the amounts and distributions of volatiles in the recent past on Mars. In planning for the gamma-ray spectrometer experiment that is scheduled to fly on the Mars Observer, many calculations were done on the nuclear reactions that should occur in the Martian surface, studying especially the production and transport of neutrons. It is found that three aspects of Mars can very significantly affect the production of cosmogenic products in Mars: the Martian atmosphere and the presence of H2O in or CO2 on the surface of Mars. These volatile components can greatly affect the energy and spatial distributions of neutrons, expecially those with thermal or near thermal energies, in the surface of Mars. In turn, these neutrons produce many cosmogenic nuclides that can be observed in samples returned from Mars.
Author

**N89-18350*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**MARS ROVER SAMPLE RETURN: AN EXOBIOLOGY SCIENCE SCENARIO** **c12**
D. A. Rosenthal, M. H. Sims, Deborah E. Schwartz, S. S. Nedell, Christopher P. McKay, and Rocco L. Mancinelli *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 145-146 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 22A

A mission designed to collect and return samples from Mars will provide information regarding its composition, history, and evolution. At the same time, a sample return mission generates a technical challenge. Sophisticated, semi-autonomous, robotic spacecraft systems must be developed in order to carry out complex operations at the surface of a very distant planet. An interdisciplinary effort was conducted to consider how much a Mars mission can be realistically structured to maximize the planetary science return. The focus was to concentrate on a particular set of scientific objectives (exobiology), to determine the instrumentation and analyses required to search for biological signatures, and to evaluate what analyses and decision making can be effectively performed by the rover in order to minimize the overhead of constant communication between Mars and the Earth. Investigations were also begun in the area of machine vision to determine whether layered sedimentary structures can be recognized autonomously, and preliminary results are encouraging. Author

**N89-18351*#** Auburn Univ., AL. Dept. of Geology.
**VOLCANIC ROCKS AND THE GEOLOGIC HISTORY OF MARS**
P. A. Salpas *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 147-148 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

A number of questions exist regarding the geology of Mars which can be addressed by the proposed Mars rover-sample return mission. The use of a rover during the proposed mission greatly enhances the ability to investigate multiple aspects of Martian geology and geological history. Attempting to address all of the important questions may dilute the amount of information that can be obtained regarding each question and may result in no satisfactory answers. Prioritization is essential to a successful mission. The task of setting priorities is simplified somewhat when it is considered that answers to some of these questions do not require taking samples, and that for some questions, sample location is not as important as for others. The surface of Mars

presents two distinct terrains, both of which have the potential to contain valuable information regarding the composition of Mars.
Author

**N89-18352*#** Brown Univ., Providence, RI. Dept. of Geological Sciences.
**THE ROLE OF IMPACT CRATERING FOR MARS SAMPLE RETURN**
P. H. Schultz *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 149-150 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The preserved cratering record of Mars indicates that impacts play an important role in deciphering Martian geologic history, whether as a mechanism to modify the lithosphere and atmosphere or as a tool to sample the planet. The various roles of impact cratering in adding a broader understanding of Mars through returned samples are examined. Five broad roles include impact craters as: (1) a process in response to a different planetary localizer environment; (2) a probe for excavating crustal/mantle materials; (3) a possible localizer of magmatic and hydrothermal processes; (4) a chronicle of changes in the volcanic, sedimentary, atmospheric, and cosmic flux history; and (5) a chronometer for extending the geologic time scale to unsampled regions. The evidence for Earth-like processes and very nonlunar styles of volcanism and tectonism may shift the emphasis of a sampling strategy away from equally fundamental issues including crustal composition, unit ages, and climate history. Impact cratering not only played an important active role in the early Martian geologic history, it also provides an important tool for addressing such issues.
Author

**N89-18353*#** Geological Survey, Flagstaff, AZ.
**MARS SAMPLE RETURN: RECOMMENDED SITES**
D. H. Scott *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 151-153 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Site selection priorities for a Mars sample return are constrained by the risks due to terrain that affect the successful descent and mobility of the sampling vehicle. At this time, evaluations of terrain roughness can be made only in a very general way. For this reason, the two candidate sites discussed are provisionally recommended primarily on the basis of their scientific value; however, no adverse surface conditions are discernable at these locations at the resolution of Viking images. The rationale is given for the selection of the sites.
Author

**N89-18354*#** Geological Survey, Flagstaff, AZ.
**MARTIAN SAMPLE SITES: EXAMPLES BASED ON A GLOBAL GEOLOGIC PERSPECTIVE**
D. H. Scott and K. L. Tanaka *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 154-155 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Ten areas were selected that each include several rock units of varying lithology and age. These areas were chosen to optimize the geologic and chronologic data return from Mars. Geologic mapping and stratigraphic studies identify stratigraphic ages, rock types, and information on Martian geologic history that samples of a given site may yield. Volcanic rocks occur over much of the planet and in virtually all stratigraphic positions, and they are amenable to radioisotopic dating. Therefore, a reasonable and essential goal for a sample return mission is to return datable rocks from widely varying strata. Generally, about three or four major geologic units can be sampled at any of the given sites, most of which can probably be dated. The Mars Observer mission will aid greatly in interpreting lithology and defining contacts at the high resolution required to actually pinpoint good sample acquisition sites within these areas.
Author

**N89-18355*#** Arizona Univ., Tucson. Lunar and Planetary Lab.
**SAMPLING STRATEGIES ON MARS: REMOTE AND NOT-SO-REMOTE OBSERVATIONS FROM A SURFACE ROVER**
R. B. Singer *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 156-157 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The mobility and speed of a semi-autonomous Mars rover are of necessity limited by the need to think and stay out of trouble. This consideration makes it essential that the rover's travels be carefully directed to likely targets of interest for sampling and in situ study. Short range remote sensing conducted from the rover, based on existing technology, can provide significant information about the chemistry and mineralogy of surrounding rocks and soils in support of sampling efforts. These observations are of course of direct scientific importance as well. Because of the small number of samples actually to be returned to Earth, it is also important that candidate samples be analyzed aboard the rover so that diversity can be maximized. It is essential to perform certain types of analyses, such as those involving volatiles, prior to the thermal and physical shocks of the return trip to Earth. In addition, whatever measurements can be made of nonreturned samples will be important to enlarge the context of the detailed analyses to be performed later on the few returned samples. Some considerations related to these objectives are discussed.
Author

**N89-18356*#** Glasgow Univ. (Scotland). Dept. of Civil Engineering.
**SOIL MICROSTRUCTURE AND ELECTRON MICROSCOPY**
**c25**
P. Smart and J. R. Fryer *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 158-159 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

As part of the process of comparing Martian soils with terrestial soils, high resolution electron microscopy and associated techniques should be used to examine the finer soil particles, and various techniques of electron and optical microscopy should be used to examine the undisturbed structure of Martian soils. To examine the structure of fine grained portions of the soil, transmission electron microscopy may be required. A striking feature of many Martian soils is their red color. Although the present-day Martian climate appears to be cold, this color is reminiscent of terrestial tropical red clays. Their chemical contents are broadly similar.
Author

**N89-18357*#** Cornell Univ., Ithaca, NY. Center for Radiophysics and Space Research.
**FLUVIAL PROCESSES ON MARS: EROSION AND SEDIMENTATION**
Steven W. Squyres *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 160-161 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

One of the most important discoveries of the Mariner 9 and Viking missions to Mars was evidence of change of the Martian surface by the action of liquid water. From the standpoint of a Mars Rover/Sample Return Mission, fluvial activity on Mars is important in two ways: (1) channel formation has deeply eroded the Martian crust, providing access to relatively undisturbed subsurface units; and (2) much of the material eroded from channels may have been deposited in standing bodies of liquid water. The most striking fluvial erosion features on Mars are the outflow channels. A second type of channel apparently caused by flow of liquid water is the valley systems. These are similar to terrestial drainage systems. The sedimentary deposits of outflow channels are often difficult to identify. No obvious deposits such as deltaic accumulations are visible in Viking images. Another set of deposits that may be water lain and that date approx. from the epoch of outflow channels are the layered deposits in the Valles Marineris. From the standpoint of a Mars Rover/Sample Return

mission, the problem with all of these water-lain sediments is their age, or rather the lack of it. Author

**N89-18358*#** Colorado Univ., Boulder. Dept. of Astrophysical, Planetary, and Atmospheric Sciences.
**MARS ORBITAL TETHERED SAMPLE RETURN: THE FEASIBILITY AND USES OF OBTAINING ENTRAINED PARTICULATES FROM THE ATMOSPHERE Abstract Only** **c12**
S. A. Stern *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 162 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 22A

By employing technology developed for the Tethered Satellite Program, it appears feasible to obtain Martian dust samples from the atmosphere using an orbiting spacecraft. If collected during an annual dust storm, such a sample would contain a global selection of windborne materials. Atmospheric dust sampling is of importance to the study of Martian surface geochemistry, soil mechanics, atmospheric dynamics, and atmospheric and radiative transfer. Tethered sample return offers two key advantages over a lander sample return: relative simplicity and low spacecraft weight. In another vein, the collection of atmospheric dust by a lander sample return mission is itself of scientific merit. By employing a mast and collection plate aboard a lander mission, it is possible to obtain dust from distant locations transported as entrained material in the local aeolian environment. Author

**N89-18359*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**EXPERIMENTAL SIMULATIONS OF OXIDIZING CONDITIONS AND ORGANIC DECOMPOSITION ON THE SURFACE OF MARS Abstract Only** **c25**
C. R. Stoker, Rocco L. Mancinelli, and Christopher P. McKay *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 163 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

One important scientific objective of a Mars Rover Sample Return mission would be to look for traces of living and extinct life on Mars. An instrument to search for organic carbon may be the simplest instrument that could screen samples which are interesting from a biological point of view. An experimental program is described which would help to understand the nature of the oxidizing soil on Mars and the mechanism responsible for organic degradation on the Martian surface. This is approached by lab simulations of the actual conditions that occur on Mars, particularly the oxidant production by atmospheric photochemistry, and the combined effects of UV light and oxidants in decomposing organic compounds. The results will be used to formulate models of the photochemistry of the atmospheric, the atmosphere-soil interaction, and the diffusion of reactive compounds into the soils. This information will provide insights and constraints on the design of a sampling strategy to search for organic compounds on Mars. Author

**N89-18360*#** Arizona Univ., Tucson. Lunar and Planetary Lab.
**NOBLE GASES AS TRACERS OF THE ORIGIN AND EVOLUTION OF THE MARTIAN ATMOSPHERE AND THE DEGASSING HISTORY OF THE PLANET**
T. D. Swindle *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 164 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Noble gas analysis of Martian samples can provide answers to a number of crucial questions. Some of the most obvious benefits will be in Martian chronology, using techniques that have been applied to lunar samples. However, these are by no means the only relevant noble gas studies possible. Since Mars has a substantial atmosphere, noble gases can be used to study the origin and evolution of that atmosphere, including the degassing history of the planet. This type of study can provide constraints on: (1) the total noble gas inventory of the planet, (2) the number of noble gas reservoirs existing, and (3) the exchange of gases between these reservoirs. How to achieve these goals are examined. Author

**N89-18361*#** Geological Survey of Japan, Ibaraki.
**EXAMINATION OF MARTIAN SEDIMENTARY ROCKS TO UNDERSTAND POSSIBLE PALEO-OCEAN AND ITS AGE Abstract Only**
T. Tanaka *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 166 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

It is well known that the terrestrial marine sediments have large cerium anomaly on their chondrite-normalized REE pattern. Siliceous shale and calcaleous sediments have negative Ce-anomaly. Ferromanganese nodule have positive or negative Ce-anomaly. The Ce-anomaly is considered to be a result of tetravalent state of cerium rather than common trivalent. Ferromanganese nodule which formed under reducing condition has negative Ce-anomaly. Then, combined study of Ce-anomaly with Ce isotopes is expected to play an important role in geochemistry. La-138 decays to Ce-138 and Ba-138 with a total half life of about 1 x 10 to the 11th years. Cerium anomalies (positive or negative) are expected in Martian paleo-ocean and in sediments as observed in the terrestrial environment. A list of things to be examined is given. Author

**N89-18362*#** Geological Survey, Denver, CO.
**U-Th-Pb, Sm-Nd, Rb-Sr, AND Lu-Hf SYSTEMATICS OF RETURNED MARS SAMPLES** **c25**
M. Tatsumoto and W. R. Premo *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 167-168 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

The advantage of studying returned planetary samples cannot be overstated. A wider range of analytical techniques with higher sensitivities and accuracies can be applied to returned samples. Measurement of U-Th-Pb, Sm-Nd, Rb-Sr, and Lu-Hf isotopic systematics for chronology and isotopic tracer studies of planetary specimens cannot be done in situ with desirable precision. Returned Mars samples will be examined using all the physical, chemical, and geologic methods necessary to gain information on the origin and evolution of Mars. A returned Martian sample would provide ample information regarding the accretionary and evolutionary history of the Martian planetary body and possibly other planets of our solar system. Author

**N89-18363*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**EARTH-BASED RADAR CONTRIBUTION TO MARS SAMPLE RETURN**
T. W. Thompson and L. Roth *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 169-170 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Earth based radar has often observed planets decades before space missions and provided valuable information leading to the success of those missions. As a Mars Sample Return Mission is contemplated, possible measurements by earth based radar should be reviewed. Earth based radars provide measurements of topography, bulk dielectric constants, rms slopes, and surface rock populations. All of these measurement will be valuable to a Mars Sample Return Mission. The 1988 and 1990 oppositions provide excellent positions for the extension of southern earth based coverage of Mars to -25 deg, while oppositions for the rest of the 1990's will provide coverage of northern latitudes to 25 deg. Author

**N89-18364*#** Boston Univ., MA. Dept. of Geology.
**CRYSTAL FRACTIONATION IN THE SNC METEORITES: IMPLICATIONS FOR SAMPLE SELECTION**
Allan H. Treiman *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 171-172 Previously

announced as N88-29698 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Almost all rock types in the SNC meteorites are cumulates, products of magma differentiation by crystal fractionation (addition or removal of crystals). If the SNC meteorites are from the surface of Mars or near subsurface, then most of the igneous units on Mars are differentiated. Basaltic units probably experienced minor to moderate differientation, but ultrabasic units probably experienced extreme differentiation. Products of this differentiation may include Fe-rich gabbro, pyroxenite, periodotite (and thus serpentine), and possibly massive sulfides. The SNC meteorites include ten lithologies (three in EETA79001), eight of which are crystal cumulates. The other lithologies, EETA79001 A and B are subophitic basalts. Author

**N89-18365*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**SAMPLE SELECTION AND PRESERVATION TECHNIQUES FOR THE MARS SAMPLE RETURN MISSION** **c19**
Fun-Dow Tsay *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 173-174 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 14B

It is proposed that a miniaturized electron spin resonance (ESR) spectrometer be developed as an effective, nondestructivew sample selection and characterization instrument for the Mars Rover Sample Return mission. The ESR instrument can meet rover science payload requirements and yet has the capability and versatility to perform the following in situ Martian sample analyses: (1) detection of active oxygen species, and characterization of Martian surface chemistry and photocatalytic oxidation processes; (2) determination of paramagnetic Fe(3+) in clay silicate minerals, Mn(2+) in carbonates, and ferromagnetic centers of magnetite, maghemite and hematite; (3) search for organic compounds in the form of free radicals in subsoil, and detection of Martian fossil organic matter likely to be associated with carbonate and other sedimentary deposits. The proposed instrument is further detailed. Author

**N89-18366*#** Max-Planck-Inst. fuer Chemie, Mainz (Germany, F.R.).
**OVERVIEW OF MARS: SNC METEORITE RESULTS**
H. Waenke *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 175-176 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

The SNC meteorites according to their oxygen isotope ratios and various trace element ratios form a distinct group of 8 achondrites. Their young crystallization ages and fractionated REE pattern which exclude an asteroidal origin, were the first observations to point towards Mars as their parent body. In spite of the many arguments for Mars as the parent body of the SNC meteorites there does not exist a generally accepted model for the ejecting process and other dynamical problems involved. In this discussion it is, however, assumed that Mars is the SNC parent body. The chemical composition of Mars is examined. Author

**N89-18367*#** Houston Univ., TX. Dept. of Geosciences.
**PROCESSING AND REDISTRIBUTION OF SURFACE AND SUBSURFACE SAMPLES BY IMPACT CRATERING**
A. Woronow *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 177-178 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

As a portion of the Martian surface becomes more densely cratered, the more the surface and subsurface materials become laterally redistributed and impact metamorphosed. Specimen redistribution is characterized as a function of both impact density and original specimen depth, and the impact histories of those specimens are also characterized. Author

**N89-18368*#** Open Univ., Milton (England). Dept. of Earth Sciences.
**STABLE ISOTOPIC STUDIES OF H,C,N,O AND S IN SAMPLES OF MARTIAN ORIGIN** **c25**
I. P. Wright and C. T. Pillinger *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 179-180 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 07D

The present day geochemical cycles of volatile elements through the various reservoirs on Earth are largely understood within the context of the planet's standing as a geologically and biologically evolved body. In terrestrial studies stable isotope measurements of light elements (H, C, N, O and S) can be utilized to obtain insight into the conditions prevailing during formation of rocks of various types. Perhaps the most important problem which could be addressed by light element studies of the sorts of specimen likely to be available from remote automatic sampling, would be the role of volatiles during evolution. Of fundamental importance here is the question of whether Mars was volatile rich or volatile poor. The only way to fully comprehend the effects of volatile cycling through the mantle crust and regolith atmosphere polar cap system of Mars, is by analyses of appropriate returned samples. In order to interpret the record of geological activity in Martian samples it will be necessary to understand how the past, or present, surface environment may have acted to disturb the primary characteristics of the rocks. Author

**N89-18369*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**IN SITU XRF AND GAMMA RAY SPECTROMETER FOR MARS SAMPLE RETURN MISSION** **c35**
I. Yin Lo, Jacob I. Trombka, Larry G. Evans, and Steven W. Squyres (Cornell Univ., Ithaca, NY.) *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 182-183 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 14B

A combined in situ X-ray fluorescence (XRF) and passive gamma ray spectrometer instrument is proposed for the chemical elemental analysis of various Martian surfaces and samples. The combined instrument can be carried on board a rover. The passive gamma ray or the neutron excited gamma ray system would be used to determine the elemental composition of the Martian surface while the rover is in motion. The XRF system would be used to perform analysis either on the Martian surface or on collected samples when the rover is stationary. The latter function is important both in cataloging the collected samples and in the selection of samples to be returned to earth. For both systems, data accumulation time would be on the order of 30 minutes. No sample preparation would be necessary. Author

**N89-18370*#** Hawaii Univ., Honolulu. Planetary Geosciences Div.
**THE RECORD OF MARTIAN CLIMATIC HISTORY IN CORES AND ITS PRESERVATION**
A. P. Zent *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 184-185 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Among the questions to be addressed by a Mars Sample Return Mission are the history of the Martian climate and the mechanisms that control the volatile cycles. Unfortunately, the evidence that bears most strongly on those issues lies in the volatile distribution in, and physical configuration of, a very delicate and volatile system: the uppermost Martian regolith. Some useful measurements to be made on returned samples of the regolith are identified, along with the many critical considerations in ensuring the usefulness of returned samples. Author

**N89-18371*#** Lunar and Planetary Inst., Houston, TX.
**PRESENT IMAGING LIMITATIONS TO PROVIDING A GEOLOGICAL ASSESSMENT OF POTENTIAL SAMPLE RETURN SITES ON MARS**
James R. Zimbelman *In its* Workshop on Mars Sample Return

Science 1988 p 186-187 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

A Mars sample return mission will provide a huge increase in knowledge about the region explored by the roving vehicle. However, presently there are some important limitations on the extent to which the geology of a potential site can be understood prior to landing the sample return vehicle on Mars. These limitations could affect not only the potential science return of the mission but also the safety of the vehicle. These limitations are examined. Author

**N89-18372*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**COMPUTER MODELING OF THE MINERALOGY OF THE MARTIAN SURFACE, AS MODIFIED BY AQUEOUS ALTERATION**
M. E. Zolensky, W. L. Bourcier (Lawrence Livermore National Lab., CA.), and J. L. Gooding *In* Lunar and Planetary Inst., Workshop on Mars Sample Return Science 1988 p 188-189 (For primary document see N89-18288 10-91)
Avail: NTIS HC A09/MF A01 CSCL 03B

Mineralogical constraints can be placed on the Martian surface by assuming chemical equilibria among the surface rocks, atmosphere and hypothesized percolating groundwater. A study was made of possible Martian surface mineralogy, as modified by the action of aqueous alteration, using the EQ3/6 computer codes. These codes calculate gas fugacities, aqueous speciation, ionic strength, pH, Eh and concentration and degree of mineral saturation for complex aqueous systems. Thus, these codes are also able to consider mineralogical solid solutions. These codes are able to predict the likely alteration phases which will occur as the result of weathering on the Martian surface. Knowledge of the stability conditions of these phases will then assist in the definition of the specifications for the sample canister of the proposed Martian sample return mission. The model and its results are discussed. Author

**N89-18373*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**PROCEEDINGS OF THE POLAR PROCESSES ON MARS WORKSHOP**
Robert M. Haberle Dec. 1988 59 p Workshop held in Sunnyvale, CA, 12-13 May 1988
(NASA-CP-10021; A-89001; NAS 1.55:10021) Avail: NTIS HC A04/MF A01 CSCL 03B

Included in this publication is a collection of abstracts from the NASA-sponsored workshop, Polar Processes on Mars, which was held at the Sunnyvale Hilton Hotel, Sunnyvale, California, on 12 to 13 May 1988. Support for the workshop came from NASA's Planetary Geology and Geophysics program managed by Dr. Jospeh Boyce. The workshop is one of a series identified by MECA (an acronym for Mars: Evolution of its Climate and Atmosphere) as being worthy of focused research, but one for which it was not possible to hold during the project's lifetime. Consequently, it was held after the project ended. The MECA project was part of the Mars Data Analysis program. The workshop consisted of four sessions: The Polar Caps, Dynamics/Atmospheric Processes, Polar Geology, and Future Measurements. To put things into perspective, each of the first three sessions began with a review. All sessions were scheduled to allow ample time for discussion. A brief review of each session is provided. Author

**N89-18383*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE POSSIBLE CONTAMINATION OF JUPITER**
Joe Garcia *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 29-32 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 03B

# 92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.

For related information see *93 Space Radiation.*

**N89-18374** California Univ., Los Angeles.
**A MEASUREMENT OF THE ROTATIONAL FREQUENCY SPLITTING OF THE SOLAR FIVE-MINUTE OSCILLATIONS Ph.D. Thesis**
Steven Tomczyk 1988 187 p
Avail: Univ. Microfilms Order No. DA8822194

Observations of the solar five minute acoustic oscillations were employed to probe the below the surface rotations of the sun. The oscillations were observed in the solar photospheric velocity field. Full disk velocity images were obtained with a magneto-optical filter which employs magneto-optical effects in an atomic vapor of sodium to isolate alternate wings of a spectral line. The observations were obtained in summer of 1984. The time series of velocity images were analyzed to yield the rotational frequency splitting of oscillation modes with spherical harmonic degrees ranging from 5 to 120. These results show the solar rotation rate to decrease with depth inside the sun over the depth range studied. Also, the rate of differential rotation is observed to decrease with depth inside the sun. Dissert. Abstr.

**N89-18375*#** Stanford Univ., CA. Center for Space Science and Astrophysics.
**AN INVESTIGATION OF GROUND-BASED OBSERVATIONS OF SOLAR OSCILLATIONS AT STANFORD**
Harald M. J. Henning Dec. 1987 225 p
(Contract NGR-05-020-559; N00014-86-K-0085; NSF ATM-86-18263)
(NASA-CR-184763; NAS 1.26:184763; SU-CSSA-ASTRO-87-21)
Avail: NTIS HC A10/MF A01 CSCL 03B

Data obtained in the last 8 years of solar differential Doppler observations at Stanford were considered. The four best time series of data were examined in detail. The sources of error in the data were investigated and removed where possible. In particular, the contribution resulting from transparency variations in the sky was examined. Detection method applicable to data with low signal to noise ratio and low filling factor were developed and utilized for the investigation of global solar modes of oscillations in the data. The frequencies of p-modes were measured and identified. The presence of g-modes were also determined in the Stanford data. B.G.

**N89-18376*#** Stanford Univ., CA. Center for Space Science and Astrophysics.
**SOLAR g-MODE OSCILLATIONS: COMPARISON OF SMM-ACRIM AND GROUND-BASED OBSERVATIONS Final Report, 1 Jul. 1987 - 30 Jun. 1988**
Philip H. Scherrer Feb. 1989 6 p
(Grant NAG5-944)
(NASA-CR-184762; NAS 1.26:184762; SU-SPO-4672) Avail: NTIS HC A02/MF A01 CSCL 03B

Progress was made in access to data and in developing programs for its analysis. The difficulties in completing the work in the planned time can be traced to several factors. The correction of the Stanford oscillation using gridded intensity data was not successful. It was concluded that due to poor continuity of the 1985 and 1986 data due to clouds, that a joint analysis with the ACRIM data (best solar oscillation data to date) on the summer 1987 observations should be performed. The 1988 Stanford oscillation data are being examined and the cross comparison of the ACRIM spectrum with the Standford spectrum for 1987 in the g-mode regime will shortly begin. Author

# 93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

**N89-18377** Nottingham Univ. (England).
**FLUCTUATIONS IN THE TEMPORAL DISPERSION OF MUONS IN EAS Ph.D. Thesis**
V. S. Collis 1987 384 p
Avail: Univ. Microfilms Order No. BRD-81673

Measured fluctuations in the temporal dispersion of muons within Extensive Air Showers (EASs), initiated by primaries of energy, as deduced from the risetime measurements made on the signals from Nottingham muon fast-timing recording systems, operated within the Haverah Park EAS arrays are examined. The study of muon risetimes provides an instrument in the analysis of the first stages in the development of the nuclear cascade in EAS, and therefore is important in establishing constraints on the mass composition of the primary cosmic rays. The EAS detected by the two 5 sq m co-located muon detectors have their muon risetimes characterized by T (sub 70), the time elapsed between the 10 percent level and the 70 percent level of the fully integrated muon signal from scintillators. Correlation analyses are undertaken between T (sub 70) and three other detector-based parameters, Mu/c (the local ratio of the muon density to water-Cerenkov density), n (sub c) (the water-Cerenkov lateral distribution function exponent), e. t (sub 1/2) (the water-Cerenkov risetime parameter), each believed sensitive to EAS development and collected during the infilled period of the Haverah Park array, 1978 to 1980. These investigations provide strong evidence that between-shower fluctuations are real and large. T (sub 70) measurements are evaluated against similar muon risetime data recorded at both the Akeno and Chacaltaya EAS arrays. Normalization parameters are derived. Results on the fluctuation width are compared with EAS development model predictions. Dissert. Abstr.

**N89-17749#** Cambridge Univ. (England).
**REMOTE SENSING OF INTERPLANETARY SHOCKS USING A SCINTILLATION METHOD**
A. Hewish *In* AGARD, Scattering and Propagation in Random Media Mar. 1988 6 p (For primary document see N89-17706 10-31)
Copyright Avail: NTIS HC A23/MF A01

# 99 GENERAL

**N89-18378*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**NASA AMES SUMMER HIGH SCHOOL APPRENTICESHIP RESEARCH PROGRAM: 1986 RESEARCH PAPERS**
Patricia Powell Washington, DC Sep. 1988 138 p Program held in Moffett Field, CA, 16 Jun. - 15 Aug. 1986
(NASA-TM-100047; A-88035; NAS 1.15:100047) Avail: NTIS HC A07/MF A01 CSCL 05I

Engineering enrollments are rising in universities; however the graduate engineering shortage continues. Particularly, women and minorities will be underrepresented for many years. As one means of solving this shortage, Federal agencies facing future scientific and technological challenges were asked to participate in the Summer High School Apprenticeship Research Program (SHARP). This program was created to provide an engineering experience for gifted female and minority high school students at an age when they could still make career and education decisions. The SHARP program is designed for high school juniors who are U.S. citizens, are 16 years old, and who have very high promise in math and science through outstanding academic performance in high school. Students who are accepted into this summer program will earn as they learn by working 8 hr days in a 5-day work week. Reports from SHARP students are presented. For individual titles, see N89-18379 through N89-18396.

**N89-18379*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**LIVING AND WORKING IN SPACE** **c54**
Linda Armstrong *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 1-8 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 05H

A brief overview is presented of the space station concept. Living conditions in space, space station design, and space logistics are briefly examined. E.R.

**N89-18380*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**V/STOL AIRCRAFT AND THE PROBLEM OF JET-INDUCED SUCKDOWN** **c05**
Cherianne Carlisle *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 9-20 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 01C

The suckdown condition encountered when jet propelled, Vertical/Short Takeoff and Landing aircraft hover near the ground is described. A discussion of this ground effect problem and how it is being investigated is followed by a more detailed description of one of the methods researchers are using to investigate the basic mechanisms that influence the suckdown condition. Specific parameters that are taken into account include the height of the jet above the ground, jet exit conditions, and model geometry. Data from a current investigation is presented along with some conclusions from other recent investigations in order to relate the significance of some of the parameters influencing suckdown. Suggestions are made for additional testing methods which might be useful to researchers investigating the mechanisms involved in jet induced suckdown. Author

**N89-18381*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**MOTION SICKNESS: CAN IT BE CONTROLLED** **c52**
David Carnes *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 21-23 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 06E

NASA is one of the few research centers concerned with motion sickness. Since the physiology of man has been developed in the one-gravity field Earth, the changes experienced by man in space are unique, and often result in symptoms that resemble motion sickness on Earth. NASA is concerned with motion sickness because it is very uncomfortable for the astronauts. Another concern of NASA is the possibility of a motion sickness astronaut regurgitating while he or she is sealed in an airtight space suit. This could be fatal. Motivated by these reasons, NASA spent thousands of dollars in research and development for a drug or technique for combating motion sickness. Several different treatments were developed for this disorder. Three of the most effective ways of combatting motion sickness are discussed.
Author

**N89-18382*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**IBM PC ENHANCES THE WORLD'S FUTURE** **c60**
Jozelle Cox *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 25-28 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 09B

Although the purpose of this research is to illustrate the importance of computers to the public, particularly the IBM PC, present examinations will include computers developed before the IBM PC was brought into use. IBM, as well as other computing facilities, began serving the public years ago, and is continuing to find ways to enhance the existence of man. With new developments

in supercomputers like the Cray-2, and the recent advances in artificial intelligence programming, the human race is gaining knowledge at a rapid pace. All have benefited from the development of computers in the world; not only have they brought new assets to life, but have made life more and more of a challenge everyday. Author

**N89-18383*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE POSSIBLE CONTAMINATION OF JUPITER** **c91**
Joe Garcia *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 29-32 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 03B

The Galileo probe, though at present its future is uncertain, would, if not sterilized, represent a good chance of contaminating Jupiter. Most scientists opposed to sterilizing the probe argue that to order the probe sterilized would be the death of the project, since sterilization would entail a reconstruction of the probe, and there are not enough funds to accomplish this. These scientists, however, are ignoring a relatively simple and inexpensive alternative to the traditional heat sterilization method. The main threat of contamination comes from Galileo's exterior surfaces: the shell of the probe and its parachute. The probe innermost components would not represent a threat since the probe is sealed. In light of the fact that only the exterior of Galileo would have to be sterilized, heat would not have to be used as a method of sterilization. Instead, various gas mixtures could be sprayed entirely over the probe and its parachute, gases which would kill any and all bacteria. This idea is more thoroughly examined. Author

**N89-18384*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE VERTICAL MOTION SIMULATOR** **c09**
Todd Hosein *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 33-37 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 14B

Today's flight simulators, such as NASA's multimillion dollar Vertical Motion Simulator (VMS), recreate an authentic aircraft environment, and reproduce the sensations of flight by mechanically generating true physical events. In addition to their application as a training tool for pilots, simulators have become essential in the design, construction, and testing of new aircraft. Simulators allow engineers to study an aircraft's flight performance and characteristics without the cost or risk of an actual test flight. Because of their practicality, simulators will become more and more important in the development and design of new, safer aircraft. Author

**N89-18385*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**CIVIL ENGINEERING** **c13**
Katie Kenning *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 39-42 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 13B

A brief overview is presented of civil engineering. What it means is defined, why it's important to society, and the training necessary to become one is briefly examined. E.R.

**N89-18386*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE DREAM OF A NATION**
Alfredo Martinez *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 43-47 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 05D

A challenging new era is under consideration and on its way. With it, comes new problems and questions to solve and answer. Nevertheless, positive thinking is required of all those who participate in or share part of the Space Station's responsibility. Hence, no longer is space an unknown, unreachable environment. It is simply a place for men and women to live, work, and learn. Author

**N89-18387*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE NATIONAL AERO-SPACE PLANE** **c05**
Bruce Mendez *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 49-53 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 01C

The National Aerospace Plane is an extremely versatile and adaptable aircraft. It can be developed into an Orient Express that would dramatically improve trade with countries in Asia and elsewhere: a commuter transport to ferry men and materials to space, an advanced tactical fighter or bomber, and an unparalleled high altitude spy-plane to observe troubled spots all over the globe. Utilizing the technology developed by this pilot program, it will be possible to quickly and easily get to low Earth orbit, go halfway around the world in a fraction of the time it previously took, and lead the world in the development of advanced technology to improve our lives and the lives of many others. Author

**N89-18388*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE WIND TUNNELS OF THE NATIONAL FULL-SCALE AERODYNAMICS COMPLEX** **c09**
John Moon *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 55-61 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 14B

A brief overview is given of the National Full-scale Aerodynamics Complex. Its geometry, design, construction and testing conditions and models are examined. E.R.

**N89-18389*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE SPACE STATION** **c18**
Abraham Munoz *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 63-67 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 22B

Conceived since the beginning of time, living in space is no longer a dream but rather a very near reality. The concept of a Space Station is not a new one, but a redefined one. Many investigations on the kinds of experiments and work assignments the Space Station will need to accommodate have been completed, but NASA specialists are constantly talking with potential users of the Station to learn more about the work they, the users, want to do in space. Present configurations are examined along with possible new ones. Author

**N89-18390*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**CRYOGENIC MIRROR ANALYSIS** **c74**
S. Nagy *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 69-103 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 20F

Due to extraordinary distances scanned by modern telescopes, optical surfaces in such telescopes must be manufactured to unimaginable standards of perfection of a few thousandths of a centimeter. The detection of imperfections of less than 1/20 of a wavelength of light, for application in the building of the mirror for the Space Infrared Telescope Facility, was undertaken. Because the mirror must be kept very cold while in space, another factor comes into effect: cryogenics. The process to test a specific morror under cryogenic conditions is described; including the follow-up analysis accomplished through computer work. To better illustrate the process and analysis, a Pyrex Hex-Core mirror is followed through the process from the laser interferometry in the lab, to computer analysis via a computer program called FRINGE. This analysis via FRINGE is detailed. Author

**N89-18391*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**PILOT PERFORMANCE** **c54**
Jennifer Nicholls *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 105-111 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 05H

For many years, the emphasis has been placed on the performance of the aircraft, rather than on those who fly the aircraft. This is largely due to the relative safety of flying. Just in the last few years there have been several major accidents that have shown that flying is not quite as safe as it was thought to be. Sixty-five percent of these accidents are a result of pilot performance decrements, and so it is obvious that there is a need to reduce that figure. A study has been mandated to evaluate the performance of pilots. This includes workload, circadium rhythms, jet lag, and any other factors which might affect a pilot's performance in the cockpit. The purpose of this study is to find out when and why the decrement in a pilot's performance occur and how to remedy the situation. Author

**N89-18392*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE IBM PC AT NASA AMES** **c60**
James P. Peredo *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 113-118 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 09B

Like many large companies, Ames relies very much on its computing power to get work done. And, like many other large companies, finding the IBM PC a reliable tool, Ames uses it for many of the same types of functions as other companies. Presentation and clarification needs demand much of graphics packages. Programming and text editing needs require simpler, more-powerful packages. The storage space needed by NASA's scientists and users for the monumental amounts of data that Ames needs to keep demand the best database packages that are large and easy to use. Availability to the Micom Switching Network combines the powers of the IBM PC with the capabilities of other computers and mainframes and allows users to communicate electronically. These four primary capabilities of the PC are vital to the needs of NASA's users and help to continue and support the vast amounts of work done by the NASA employees. Author

**N89-18393*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**LOCAL AREA NETWORKING: AMES CENTERWIDE NETWORK** **c62**
Edwin Price *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 119-121 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 09B

A computer network can benefit the user by making his/her work quicker and easier. A computer network is made up of seven different layers with the lowest being the hardware, the top being the user, and the middle being the software. These layers are discussed. Author

**N89-18394*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE EFFECT OF SIMULATED WEIGHTLESSNESS ON PERFORMANCE AND MOOD** **c53**
Bonnie Rosenberg *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 123-130 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 05I

The performance results of the bedrest study at Ames were not what were expected. The Air Combat Maneuvering performance test was tested to assure its reliability. However, the results from this study show a continued increase in performance. One would assume that scores would become constant if not decrease by the first days of bedrest because an inverted position would affect performance. It is also interesting to observe that while the subject's moods deteriorated, their performance improved. Although the performance results were surprising, the mood results were as expected. Author

**N89-18395*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE APPLICATIONS OF COMPUTERS IN BIOLOGICAL RESEARCH** **c61**
Jennifer Wei *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 131-133 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 09B

Research in many fields could not be done without computers. There is often a great deal of technical data, even in the biological fields, that need to be analyzed. These data, unfortunately, previously absorbed much of every researcher's time. Now, due to the steady increase in computer technology, biological researchers are able to make incredible advances in their work without the added worries of tedious and difficult tasks such as the many mathematical calculations involved in today's research and health care. Author

**N89-18396*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**ANIMALS IN SPACE** **c51**
Angela White *In its* NASA Ames Summer High School Apprenticeship Research Program: 1986 Research Papers Sep. 1988 p 135-141 (For primary document see N89-18378 10-99)
Avail: NTIS HC A07/MF A01 CSCL 06C

Animals are indispensable to the space program. Their continued use could have many significant results. Those who are opposed to using animals in space should remember that space animals are treated humanely; they are necessary because results can be obtained from them that would be unobtainable from humans; and results from animal experiments can be applied to human systems. Therefore, NASA should continue to use animals in space research. Author

**N89-18397*#** National Aeronautics and Space Administration, Washington, DC.
**NASA INFORMATION SCIENCES AND HUMAN FACTORS PROGRAM Annual Report, 1987**
Lee Holcomb, ed., Ray Hood, ed., Melvin Montemerlo, ed., Martin M. Sokoloski, ed., James P. Jenkins, ed., Paul H. Smith, ed., and John D. DiBattista, ed. Sep. 1988 223 p
(NASA-TM-4064; NAS 1.15:4064) Avail: NTIS HC A10/MF A01 CSCL 05A

The FY 1987 descriptions of technical accomplishments are contained for seven areas: automation and robotics, communications systems, computer sciences, controls and guidance, data systems, human factors, and sensor technology. For individual titles, see N89-18398 through N89-18406.

**N89-18398*#** National Aeronautics and Space Administration, Washington, DC.
**AUTOMATION AND ROBOTICS** **c37**
Melvin Montemerlo *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 1-28 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 13I

The Autonomous Systems focus on the automation of control systems for the Space Station and mission operations. Telerobotics focuses on automation for in-space servicing, assembly, and repair. The Autonomous Systems and Telerobotics each have a planned sequence of integrated demonstrations showing the evolutionary

advance of the state-of-the-art. Progress is briefly described for each area of concern. B.G.

**N89-18399*#** National Aeronautics and Space Administration, Washington, DC.
**COMMUNICATIONS TECHNOLOGY** **c32**
Martin M. Sokoloski *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 31-47 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 17B

The objective of the Communications Technology Program is to enable data transmission to and from low Earth orbit, geostationary orbit, and solar and deep space missions. This can be achieved by maintaining an effective, balances effort in basic, applied, and demonstration prototype communications technology through work in theory, experimentation, and components. The program consists of three major research and development discipline areas which are: microwave and millimeter wave tube components; solid state monolithic integrated circuit; and free space laser communications components and devices. The research ranges from basic research in surface physics (to study the mechanisms of surface degradation from under high temperature and voltage operating conditions which impacts cathode tube reliability and lifetime) to generic research on the dynamics of electron beams and circuits (for exploitation in various micro- and millimeter wave tube devices). Work is also performed on advanced III-V semiconductor materials and devices for use in monolithic integrated analog circuits (used in adaptive, programmable phased arrays for microwave antenna feeds and receivers) - on the use of electromagnetic theory in antennas and on technology necessary for eventual employment of lasers for free space communications for future low earth, geostationary, and deep space missions requiring high data rates with corresponding directivity and reliability. Author

**N89-18400*#** National Aeronautics and Space Administration, Washington, DC.
**COMPUTER SCIENCES** **c60**
Paul H. Smith *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 49-81 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 09B

The Computer Science Program provides advanced concepts, techniques, system architectures, algorithms, and software for both space and aeronautics information sciences and computer systems. The overall goal is to provide the technical foundation within NASA for the advancement of computing technology in aerospace applications. The research program is improving the state of knowledge of fundamental aerospace computing principles and advancing computing technology in space applications such as software engineering and information extraction from data collected by scientific instruments in space. The program includes the development of special algorithms and techniques to exploit the computing power provided by high performance parallel processors and special purpose architectures. Research is being conducted in the fundamentals of data base logic and improvement techniques for producing reliable computing systems. Author

**N89-18401*#** National Aeronautics and Space Administration, Washington, DC.
**CONTROLS AND GUIDANCE: AERONAUTICS** **c08**
John D. DiBattista *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 83-103 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 01C

The overall objective is to provide a validated technology base leading to the development and exploitation of new concepts, analysis and design methodologies, and flight systems for future civil and military aircraft. This will provide increased efficiency, effectiveness, reliability, and safety. The program is organized into generic elements and vehicle-specific elements. The generic elements are control theory, guidance and display concepts, and flight crucial systems. Vehicle-specific elements are generic hypersonics, subsonic transport/commuter/general aviation, rotorcraft, and fighter/attack. Research in the control theory element is directed toward the improved flight control analysis and design methodologies for highly integrated, robust flight control designs. Flight Crucial Systems research is directed toward the development of design, assessment, and validation methodologies for flight crucial systems. The generic hypersonics research concentrates on the integration of flight control, propulsion control, sensors, and displays. The Aeronautical Controls and Guidance Program involves analytical and experimental research by in-house, university, and industry personnel. Extensive use of ground-based simulation is a characteristic of the program with selected flight experiments in a variety of aircraft. Author

**N89-18402*#** National Aeronautics and Space Administration, Washington, DC.
**CONTROLS AND GUIDANCE: SPACE** **c18**
John D. DiBattista *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 105-125 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 22B

The Space Controls and Guidance Research and Technology Program is directed toward enabling the next generation of space transportation systems, large future spacecraft, and space systems such as the Space Station to have large communication antennas and high precision segmented reflector astrophysical telescopes. The new generation of transportation vehicles has demanding requirements to provide for an order of magnitude reduction in cost as well as an increase in capability. The future orbital facilities have demanding control requirements for pointing and stabilization, momentum management, build-up and growth accomodation, and disturbance management. To address these advanced requirements, the research and development program is designed to provide the generic technology base to support the implementation of advanced guidance, navigation, and control. The area of computational controls will be stressed in order to develop cost effective, high speed, high fidelity control system simulation and analysis and synthesis tools. The trust of this work will be to develop methods and software to enable analysis and real-time hardware-in-the-loop simulation of complex spacecraft for control design certification. To address future orbital facilities requirements, an advanced technology program is underway in system identification, distributed control, integrated controls/structures design methods, and advanced sensors and actuators. Because the behavior of large, light weight per unit area deployable/assembled spacecraft is greatly influenced by the ground environment, the testing and verification activity is both ground- and space-based. Author

**N89-18403*#** National Aeronautics and Space Administration, Washington, DC.
**DATA SYSTEMS** **c82**
Paul H. Smith *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 127-145 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 05B

The Data Systems Program consists of research and technology devoted to controlling, processing, storing, manipulating, and analyzing space-derived data. The objectives are to provide the technology advancements needed to enable affordable utilization of space-derived data, to increase substantially the capability for future missions of on-board processing and recording and to provide high speed and high volume computational systems anticipated for missions such as the evolutionary Space Station and Earth Observing System. The Data Systems Program supports fundamental research in such areas as laser diodes, supports work to select and provide the appropriate on-board processor technology for future NASA missions, and also supports the development of two flight processors with special architectures. Author

**N89-18404*#** National Aeronautics and Space Administration, Washington, DC.
**HUMAN FACTORS: AERONAUTICS** **c54**
James P. Jenkins *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 147-177 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 05H

The objectives of the Aeronautics Human Factors Research and Technology program are to provide the technology base and capability to design effective crew-cockpit systems and to advance solutions to human problems affecting air transport and rotorcraft effectiveness and safety. Advanced automation technologies, information display capabilities under computer control, and concern for the effects of human error in flight operations are elements which drive the directions of the program. Thus, the program has four thrusts: flight management, human engineering methods, rotorcraft, and subsonic transports. Author

**N89-18405*#** National Aeronautics and Space Administration, Washington, DC.
**HUMAN FACTORS: SPACE** **c54**
James P. Jenkins *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 179-201 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 05H

The objectives are to provide a technology base for intelligent operator interfaces, especially with autonomous subsystems, and to develop a new generation of high performance space suits, gloves, and tools/end effectors to meet the requirements of advanced space missions. The technology base is intended to meet the requirements of productivity, efficiency, and safety in complex manned operations within automated onboard systems and extravehicular activities (EVA) environments. Crew station research is the first of two major areas. Development of methods for the astronaut to supervise, monitor, and evaluate the performance of robotic systems, other space subsystems, and orbital vehicles are key areas of research. The second major area is development of an EVA space suit and gloves. Emphasis in the space human factors research program is placed on technology baseline studies and development of methods, techniques, and data to support productive and safe operations by the astronaut and crew as they interface with complex systems, advance automation, and robotic assistants. Author

**N89-18406*#** National Aeronautics and Space Administration, Washington, DC.
**SENSOR TECHNOLOGY** **c35**
Martin M. Sokoloski *In its* NASA Information Sciences and Human Factors Program Sep. 1988 p 203-223 (For primary document see N89-18397 10-99)
Avail: NTIS HC A10/MF A01 CSCL 14B

The objective is to provide necessary expertise and technology to advance space remote sensing of terrestrial, planetary, and galactic phenomena through the use of electromagnetic and electro-optic properties of gas, liquid, and solid state materials technology. The Sensor Technology Program is divided into two subprograms: a base research and development part and a Civil Space Technology Initiative (CSTI) part. The base research and development consists of research on artificially grown materials such as quantum well and superlattice structure with the potential for new and efficient means for detecting electromagnetic phenomena. Research is also being done on materials and concepts for detector components and devices for measuring high energy phenomena such as UV, X-, and gamma rays that are required observables in astrophysis and solar physics missions. The CSTI program is more mission driven and is balanced among four major disciplines: detector sensors; submillimeter wave sensors; LIDAR/DIAL sensors; and cooler technology. Author

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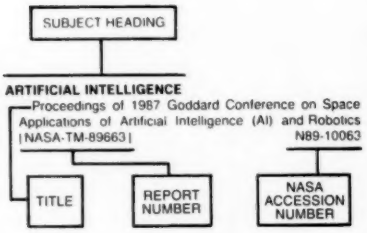


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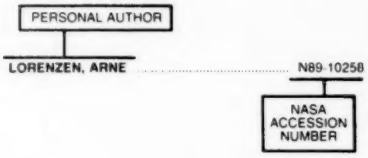


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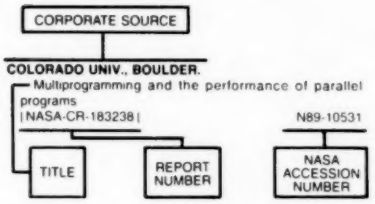


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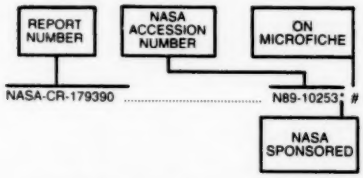


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